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LIMITED LIABILITY COMPANIES.

THE Official Returns of Electrical Companies published weekly in these columns, afford numerous instances of companies possessing a subscribed capital very small in comparison with their registered nominal capital. The proposal made by the Chancellor of the Exchequer in his recent Budget speech, to impose a duty of £1 for every £1,000 of nominal capital, will no doubt tend considerably to banish the golden visions of company promoters, and we may anticipate that in many instances the capitals of companies will be fixed nearer the amount required for carrying out the specified objects, than would be the case under existing circumstances. The present Companies' Acts, although affording a certain amount of protection to the public, present abundant opportunities for the passage of the proverbial "coach-and-four." The registration of a company is a very simple and easy matter. The promoter has only to obtain the signatures of any seven persons to the memorandum of association for a single share each, and may fix the nominal capital at as high or low a figure as his fancy dictates, and if at a loss to describe the objects of the company, may state that it proposes to carry on "any or every kind of business in any part of the world." The stamp duties having been paid and the Registrar's certificate obtained, the company is at liberty to commence operations. Mr. J. S. Purcell, the Registrar of Companies, in his evidence before the Royal Commission on the Depression of Trade, gave some interesting details and statistics concerning the registration of companies. He stated that out of 1,443 companies registered in the year 1883, with a total nominal capital of 143 millions, 430 did not proceed beyond registration; while 160 more, with a paid-up capital of 3½ millions, are either wound up or are in course of liquidation; the remaining 853, with a total capital of 32 millions, being still in existence. During 30 years from 1856, the year in which the first Limited Liability Act was passed, 26,000 companies were registered; the number carrying on business in 1886 being 9,300; and during the latter year the fees received for registrations, official returns, and for inspection amounted to £33,000.

We understand that the Lord Chancellor proposes to introduce to the House of Lords a Bill for the Amendment of the Companies' Act, which is calculated to render the incorporation of bogus concerns an extremely difficult matter. This measure provides that the name, address and occupation of the promoter shall be stated in the registered documents together with the amount he is to receive as promotion money, and also that a certain proportion of the capital must be applied for before a company can proceed to allotment; if this proportion were made considerable, say three-fourths, a very salutary effect would, we think, be produced. Life Assurance Companies are required to deposit a considerable sum with the Court of Chancery before registration can be effected, such sum being retained as security for the policy holders and creditors until the company is in a flourishing condition, a regulation which might with advantage be extended to other classes of companies.

The existing Acts require the filing of all agreements relating to the issue of shares credited as fully or partly paid up; but in the interest of intending shareholders we consider that *all* preliminary contracts should be registered, so that information may be obtainable as to the purchase consideration and the special arrangements made with various individuals for promoting and floating the company. The purchase money is usually fixed on a very liberal scale, and as the first directors are generally nominees of the promoters and vendors the purchase agreement is as a rule ratified and confirmed by the board without much difficulty. Some time ago a company was successfully launched for the purchase of a sewing machine patent. The original inventor received a small sum for his patent rights, which subsequently passed through several hands and were finally disposed of to the company for a cash payment of several thousand pounds and an allotment of a large number of fully paid shares. The shareholders now find to their cost that they are the possessors of an ingenious toy machine, but one of little practical use. It is somewhat amusing to note how very willingly vendors will lower their terms when subscriptions do not flow into the company's coffers to the extent anticipated. A company was recently formed with a large nominal capital to effect extensive electrical installations. A considerable amount must have been spent in circulating the prospectus, together with a circular setting forth the advantages offered by the company; but somehow the public fought shy, and it is rumoured that the amount subscribed was such as to render it necessary for the company to considerably modify its programme and for the present to be satisfied with one installation only. The promoter and moving-spirit of this company has magnanimously consented to receive £2,000 cash less than the amount originally agreed upon. It is obvious that this gentleman's services were either over-estimated in the first instance, or that he is now to be paid considerably less than his worth, and that the shareholders must therefore not expect too much from him. In the prospectuses of several companies recently formed it was set forth that two directors would be elected from the largest shareholders; and were such a rule imperative with all companies, additional security would be obtained for the general body of shareholders.

FOR a long time past Society journals, those devoted to literary chit-chat, and others of a more serious turn of mind, have devoted portions of their space to answering the foolish queries of correspondents. It is really almost time to make a protest against this silly fashion, more especially as the non-technical Press is trenching

upon our own ground. The following extract from last week's *Vanity Fair* is an amusing example of the kind of advice tendered to seekers after knowledge :—"To the Editor of *Vanity Fair* :—Dear Sir,—Can you recommend an investment in electric light shares? If so, please tell me which electric light you consider the safest. Answer: We hear very favourably of the prospects of an electrical lighting company just started, called the Series Electric Traction Syndicate, Limited. The shares are £1 shares, but are quoted at a premium." Perhaps the editor of our contemporary was away for his Easter holidays at the time the answer was written; anyhow, there's a "nigger" in it somewhere.

THE paper which we publish this week on electromotor construction will probably interest many amateur scientists and students of electrical engineering, although it is not likely to contain anything of value to the manufacturing electrician. Still, we consider it worth reproducing as a companion to the article on dynamos by the same author, published in our issues of the REVIEW for May 6th and 13th, 1887.

THAT system of education which consists for the most part in "cramming" pupils with certain set forms of words with which to answer anticipated questions at examination time is far from satisfactory to the educationalist who seeks the intellectual advancement of the race. Parrot-knowledge is a useless kind of thing; rather, it is not knowledge at all, and it is worse than useless. This is not a mere postulatory assumption, but it can scarcely be necessary to justify or demonstrate it to an enlightened and scientific body such as we have every reason to suppose is formed by our numerous readers. Yet, strangely enough, the antiquated plan of tuition which results in this description of "learning" has many supporters who claim to be educationalists. It is to the credit of the elementary teachers of the United Kingdom that they do not support it: they have condemned and very emphatically protested against the pernicious system of payment according to results of examinations, and they are the more to be commended as the abandonment of the practice would seem initially to tell against themselves—not against the real and true success of their teaching, but against their opportunities for adding indefinitely to their incomes by extra pressure upon their unfortunate pupils. We are glad to see enlightenment spreading with regard to a subject upon which we have for many years held strong opinions. These remarks serve to introduce a matter which has some bearing upon improved methods of elementary education. Prof. Ayrton announces a course of lectures and demonstrations in Experimental Physics for the special benefit of elementary teachers. The lectures will be given at the Central Institution of the City and Guilds of London Institute for the Advancement of Technical Education, and will occupy ten Saturday mornings, from April 21st. The aim of the course will be to exemplify the natural mode of teaching experimental physics to young students, so that they may learn to grasp the fundamental physical laws and facts, and obtain an elementary working knowledge of the subject. The methods of teaching the various branches of physics found in ordinary text-books will not be followed, but instead, the method which leads the pupils to start from their everyday knowledge of the subject and examine into the laws governing physical phenomena. The importance of teaching through the laboratory work of the students themselves, and the possibility of this being done in the case of even quite elementary students, will be fully entered into, and will be illustrated by examples of the way such teaching may be practically carried out so as to impress the more important laws firmly on the students' minds.

THE much dreaded and long looked for rules and regulations recommended for the prevention of fire risks from electric lighting have at last been issued by the Society of Telegraph-Engineers and Electricians. We may at once state, although our readers can judge for themselves, that they are absolutely innocuous, and it is a marvel to us that the protracted labours of 22 gentlemen of the highest eminence should have resulted in bringing into the world such a pigmy. We believe the conception of the idea took place at least three years since, so the tiny offspring of the committee has had ample time to germinate into a finely developed specimen of its kind, but alas, it might almost be placed in the category of the still-born. There is, however, one redeeming feature in the compilation; these puerile rules are not intended to clash with others which fire offices may issue for their own protection, and it is not likely that they ever will. The rules, such as they are, nevertheless offer a few opportunities for comment. We are told that whatever insulating material is employed, it should not soften until a temperature of 170° Faht. has been reached. Are we not correct in asserting that one of the most extensively used materials for insulating electric light conductors would attain the consistency of putty long before this temperature was approached; and is this to be tabooed entirely? The vagueness too, or rather *naïveté*, of rule 7 is delightful, and we venture to suggest that the proximity of conductors should be governed by other conditions than that of mere potential differences. The "factor of safety," also in estimating the sectional areas of leads, appears to us excessive. A skilled engineer would assuredly calculate the weights of his copper within smaller limits than that proposed, and still be on the right side. We are rather surprised that the use of fluids for soldering was not condemned, unless an exception is made in favour of Venice turpentine, which nobody seems to think of using, although it was always strongly recommended by the late Robert Sabine. It is not altogether improbable that a non-technical reader of the paragraphs relating to dynamos would come to the conclusion that they are exceedingly dangerous in positions where, so far as we are aware, they have already been extensively used without any accident. It would be however only a waste of time to seriously discuss the matter at greater length, for we are decidedly of opinion that the remarkable publication to which we have alluded will no sooner be read than laid aside and forgotten.

THERE are certain points, however, which, although old, cannot too often be impressed upon the minds of those who are engaged in electric lighting operations. The paragraphs dealing with metallically sheathed conductors, circuits in which gas or water pipes form a part, lightning protectors, transformers, maintenance, &c., are all of much importance, and we cordially agree with the committee in the statement that the greatest element of safety lies in the employment of skilled and experienced electrical engineers to specify methods, to decide upon the materials used, and to supervise the execution of the work. We have grave doubts as to whether the time has not arrived when such advice and instruction to electric light engineers cannot be entirely dispensed with, no matter from what quarter

they emanate. Fancy gas fitters having to bear in mind page upon page of matter compiled, probably, by eminent individuals who never had any practical experience in gas engineering in the whole course of their career!

THE rules and requirements of the New England Insurance Exchange for electric lighting by the arc system will be seen immediately following those just issued by the Society of Telegraph-Engineers. It may be that our readers will profit to some extent by the experience of our American cousins, whose arc lighting systems are carried out on the most extensive scale; but we do not purpose making any comments upon a matter which, except for isolated plants, has taken little or no foothold in this country.

PERHAPS some one could give us information upon a matter which we think has a great bearing upon the durability of electric lighting circuits. It is not an uncommon thing to find in the price lists of manufacturers of leads the cost per mile of conductors insulated with a given material of, say, qualities A, B and C. The first may, perhaps, be taken as having a dielectric resistance of 100 megohms per mile in water at a certain temperature, the second 50, and the third 10. Now, if the respective wires are covered with such a material as India-rubber, say in the manner which is usually adopted for submarine cables or underground conductors, then in the name of all that is wonderful how do we find such great differences in the insulation? Those who are aware of the properties of standard insulating materials would perhaps have little difficulty in arriving at a correct solution of the problem, for it is absolutely certain that the material employed in the three cases is either good, bad, or indifferent, or that the low insulation is due to incipient faults which sooner or later develop themselves and cause a complete breakdown in the insulation.

AT the date of the last session (July, 1887) of the International Conference on the protection of submarine cables only five out of the twenty-six States which had signed the Convention of 14th March, 1884, had failed to adopt the stipulations laid down by Article 12 of that Convention. These States were the Argentine Republic, Austro-Hungary, Brazil, United States, and Roumania. The Austrian Parliament some time ago passed the necessary measures, and we now learn that both the United States legislative bodies have voted the laws for the protection of submarine cables.

SOME experiments have recently been made by Herr Waltenhofen and others with the accumulators of Farbaky and Schenek, Reckenzaun and Julien. These types of secondary batteries have all been described in the REVIEW, and we notice that the Reckenzaun cells, all things considered, compare favourably with the others. We further imagine that for tramcar work, for which purpose the Reckenzaun battery under consideration was designed, it would be the best suited, both mechanically and electrically. We may, perhaps, give further details of these experiments at a later date.

SOME little while ago, when a discussion was proceeding in the Bath Town Council with regard to the electric lighting of the streets, we were asked whether it was competent for members of the Corporation who were interested in the gas company to take part in the discussions or to vote upon questions which affected their personal interests in such a capacity. We replied that we believed there was no legal restriction, but that good taste, under the circumstances, should dictate silence. A Dublin correspondent thereupon wrote that there was really an Act of Parliament which rendered it illegal for members of a Town Council so situated to vote. We see that in a discussion with respect to the appointment of a gas inspector for the Dublin Municipal Council this week the following section of an Act of Parliament was quoted :—

> That no member of the Council shall vote or take part in the discussion of any matter before the Council in which such member shall, directly or indirectly, by himself or his partners, have a pecuniary interest.

What we want now to know is whether this law is general throughout Great Britain, or whether it is local and special. Can some of our legal friends oblige us with the information?

OUR appeal to the Electrical Power Storage Company last week was not ill-timed. The working of three electric cars in Brussels during last year has resulted in a serious loss, due it is said to the rapid deterioration of the secondary batteries. What this means may be the more readily understood when we say that the depreciation of the battery is put down at 3½d. per car mile, a price at which some electric traction companies profess to be able to run inclusive of everything. We sincerely hope that something will soon be forthcoming which will withstand the jarring and jolting of tramcar traffic, for there is but little doubt that the difficulty is purely one of a mechanical nature. Of course it is possible, and, indeed, more than probable, that the batteries manufactured in this country would not be liable to such rapid deterioration as those, which, we presume, were of Julien's design, used in the Brussels cars.

THE question of independent engines for incandescent electric light stations has been ably treated by Mr. Wm. Lee Church, as may be seen in our other pages. We rarely come across a paper of such practical value as this proves to be, for it appeals to both the scientific and general reader. The advocates of both low and high-speed engines cannot read the results of Mr. Church's experience without confessing to an increased knowledge of the subject. The promoters of central stations will also be enabled to take advantage of many a wrinkle which will prove advantageous in the development of their schemes.

THE Architects' Registration Bill, introduced by Colonel Duncan, has some interest for electricians, for under it it is proposed that a council should be appointed for the purpose of registering the qualifications of every person who desires to be employed by the public as an engineer, an architect, or a surveyor, and it is but a step from the engineer to the electrician. Major-General Luard, R.E., has prepared a memorandum of objections to the Bill, which he is circulating for publication. His principal objection is that the Institution of Civil Engineers, the Royal Institute of British Architects, and Surveyors' Institution admit to membership none but those who have either passed a very searching examination or are well known to the councils as persons whose acquirements are satisfactory, and that membership of these bodies is sufficient distinction between qualified and unqualified men. He thinks the public at large are very good judges of a man's qualifications; that they prefer to find out and to distinguish for themselves between those who are qualified for their work and those who are not; and that the employment of professional men is fairly proportional to their merit.

THE BALLISTIC GALVANOMETER.

ALTHOUGH the ballistic galvanometer is but rarely used for testing purposes, yet there are one or two points about the ballistic principle which are applicable to the reflecting galvanometer.

For instance :—If q equals the quantity of electricity in an instantaneous discharge, then

$$q = \frac{2\, c_1\, t \sin \frac{1}{2} d}{\pi}$$

where c_1 is the current that produces unit deflection and t the time of half a period.

Upon the reflecting galvanometer we may take

$$q = \frac{2}{\pi}\, c_1\, t\, \frac{d}{2}$$

Now $c_1 = \frac{E_1}{R\, d_1}$ where d_1 is the deflection given through resistance, R, with E.M.F. E_1 and $t = \pi \sqrt{\frac{I}{M\, H}}$ where I is the inertia and M the magnetic moment of the needle and H the strength of the field.

$$\therefore \quad q = \frac{2}{\pi}\, \frac{E_1}{R\, d_1}\, \pi \sqrt{\frac{I}{M\, H}}\, \frac{d}{2}$$

$$\therefore \quad q = d\, \frac{E_1}{R\, d_1} \sqrt{\frac{I}{M\, H}}$$

$$\therefore \quad d = q\, \frac{R\, d_1}{E_1} \sqrt{H} \sqrt{\frac{M}{I}} \qquad (1)$$

Now $d_1 = K\, \frac{E_1}{R\, H}$ where K is evidently the deflection given by unit current in unit field.

$$\therefore \quad \sqrt{H} = \sqrt{\frac{E_1\, K}{R\, d_1}}$$

Filling this value of $\sqrt{H}$ in (1) we get

$$d = q \sqrt{\frac{R\, d_1}{E_1}} \sqrt{K} \sqrt{\frac{M}{I}}$$

If the readings d and d_1 are taken with the same battery $q = E_1\, F$ and

$$d = F \sqrt{E_1\, R\, d_1} \sqrt{K} \sqrt{\frac{M}{I}}. \qquad (2)$$

Whence $\sqrt{K} \sqrt{\frac{M}{I}} = \frac{d}{\sqrt{E_1\, R\, d_1}\, F}$. (3)

From (1) it will be seen that

$$\frac{d}{d_1\, R} = \sqrt{H}\ F \sqrt{\frac{M}{I}}.$$

That is the ratio of the discharge, d, to the constant deflection, $R\, d_1$, varies as the square root of the strength of the magnetic field.

And if the effect of the field is eliminated from the formula, then from (2)

$$\frac{d}{\sqrt{R\, d_1}} = \sqrt{E_1}\ F\ K \sqrt{\frac{M}{I}}.$$

That is the ratio of the discharge, d, to the square root of the constant deflection varies as the square root of the E.M.F. employed.

Since from (1) the discharge deflection varies as $\sqrt{\frac{M}{I}}$, the galvanometer is improved by having a needle of as great a magnetic moment and as little inertia as possible.

The value $\sqrt{K} \sqrt{\frac{M}{I}}$ in (3) is evidently the ratio of the discharge deflection, d, produced by unit quantity to the square root of the constant deflection produced by unit current.

The constancy of the value $\sqrt{K} \sqrt{\frac{M}{I}}$ is a proof that the instrument is in good condition. A decrease in this value would generally indicate that the magnetism, M, of the needle had varied,

W. MOON.

KIRCHOFF'S LAWS AND THEIR APPLICATION.

By E. C. RIMINGTON.

(*Concluded from page* 363.)

Production and Expenditure of Electrical Power in a Network.

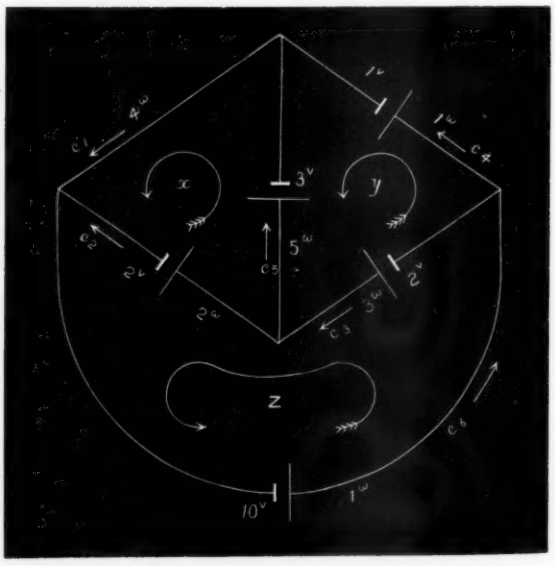
If in any network the currents in the different branches and their directions be determined by any of the methods previously given, it will in general be found that in some of the branches the currents and E.M.Fs. are in the same direction, while in others their directions are opposed.

Let $\Sigma\, E\, C$ be the sum of the products of the currents and E.M.Fs. which are in the same direction, $\Sigma\, e\, C$ the sum of the products of those in opposite directions, and $\Sigma\, C^2\, R$ the sum of the products of the square of the current in each branch into the resistance of that branch.

Then $$\Sigma\, E\, C - \Sigma\, e\, C - \Sigma\, C^2\, R = 0.$$

$\Sigma\, C^2\, R$ represents the heat evolved per unit of time in the network, $\Sigma\, E\, C$ represents the total amount of power evolved in the network, and $\Sigma\, e\, C$ the power which is expended otherwise than in heat; the form this latter takes depends on what the E.M.Fs. opposing the currents are due to.

When the E.M.F. opposing the current is due to chemical action, as in an accumulator or electrolytic cell, the power equal to the product of its E.M.F. into the current through it is expended in storing up potential chemical energy in the cell; when the opposing E.M.F. is due to some electro-magnetic engine or electric motor the power is expended in the form of mechanical power; when due to self-induction, the energy is expended in producing a magnetic field, and is restored when the latter disappears. If the E.M.F. is due to a thermo-electric effect the power will be expended in heat.



In the diagram suppose the E.M.Fs. and resistances to be as marked. Then we have the equations

$$11x - 5y - 2z = -1$$
$$-5x + 9y - 3z = 0$$
$$-2x - 2y + 5z = 10$$

Hence
$$x = \frac{291}{218}$$
$$y = \frac{249}{218}$$
$$z = \frac{732}{218}$$

The actual currents in the six conductors consequently flow in the directions represented by the arrows, and if they are called C_1 C_2 C_3 C_4 C_5 and C_6 as shown,

$$C_1 = \frac{291}{218} = 1{\cdot}335 \quad C_2 = \frac{441}{218} = 2{\cdot}023$$
$$C_3 = \frac{483}{218} = 2{\cdot}215 \quad C_4 = \frac{249}{218} = 1{\cdot}142$$
$$C_5 = \frac{42}{218} = {\cdot}1926 \quad C_6 = \frac{732}{218} = 3{\cdot}358$$

Now the currents which flow in the same direction as the E.M.Fs. acting in their branches are C_3 and C_6.

Hence the total power evolved in the network equals $2 \times 2{\cdot}215 + 10 \times 3{\cdot}358 = 38{\cdot}01$ watts.

The power expended otherwise than in heat equals $2 \times 2{\cdot}023 + 1 \times 1{\cdot}142 + 3 \times {\cdot}1926 = 5{\cdot}766$ watts.

The heat developed per second is the difference between these values or equals 32·24 watts. The latter quantity may also be found by squaring each of the currents and multiplying by the resistance of the branch in which it flows, and then adding together the products thus obtained.

When $\Sigma\, e\, C = 0$, the power evolved in the network is entirely dissipated in the form of heat since $\Sigma\, E\, C = \Sigma\, C^2\, R$, and $\Sigma\, C^2\, R$ is known as the dissipation function of the network.

Mr. W. E. Sumpner has recently introduced a simple notation for treating problems connected with networks of conductors.

On page 341, $C_{ba} = \frac{e\,\delta_{ba}}{\Delta}$; where C_{ba} is the current produced in branch b of a network when an E.M.F., e, acts in branch a.

This may be written $C_{ba} = \frac{e}{R_{ab}}$ where R_{ab} stands for $\frac{\Delta}{\delta_{ba}}$ and is a resistance function.

The resistance functions will in general be complicated expressions, but, if certain relations can be established between them, they may in many cases be eliminated from the problem and a simple result obtained.

The resistance function $R_{ab} = \frac{e}{C_{ba}}$ or is the ratio of an E.M.F. acting in a to the current it produces in b.

Since it was shown that $C_{ab} = C_{ba}$ it follows that $R_{ba} = R_{ab}$.

Again since $\frac{\delta_{xa}}{\delta_{xb}}$ is independent of the resistance of the branch x. $\frac{R_{ax}}{R_{bx}}$, $\frac{R_{ax}}{R_{xx}}$, $\frac{R_{xa}}{R_{xb}}$, $\frac{R_{xa}}{R_{bx}}$, and $\frac{R_{xa}}{R_{xx}}$ are all independent of x.

R_{xx} is the ratio of any E.M.F. acting in x to the current it produces in that branch, consequently R_{xx} must represent the resistance of the branch, x, plus the resistance of the network external to x.

As the current in any branch due to various E.M.Fs. in the network is the algebraical sum of the currents in that branch due to each E.M.F. acting separately

$$C_a = \frac{e_a}{R_{aa}} + \Sigma\, \frac{e_x}{R_{xa}}$$

where $\Sigma\, \frac{e_x}{R_{xa}}$ is the algebraical sum of the currents produced in a by the E.M.Fs. acting in the branches external to a; the expression for C_a may be written

$$C_a = \frac{e_a}{R_{aa}} + \frac{1}{R_{aa}} \cdot \Sigma\, \frac{R_{ax}}{R_{xa}}\, e$$

Now both $\frac{R_{ax}}{R_{xa}}$ and e_x are independent of the values of a and e_a, so we may write

$$C_a = \frac{e_a + K}{R_{aa}};$$

where K is a quantity independent of a and e_a.

Again
$$C_a = \frac{e_b}{R_{ba}} + \Sigma\, \frac{e_x}{R_{xa}}.$$

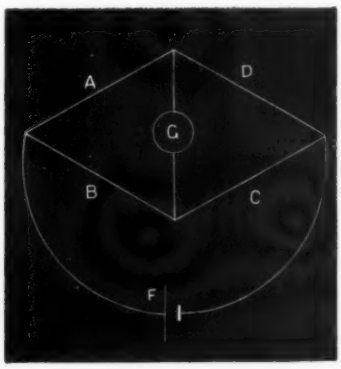
When the branches b and a are conjugate, any alteration in e_b will not affect the value of C_a.

This can only happen if R_{ba} is infinite, or

$$C_a = \Sigma\, \frac{e_x}{R_{xa}}.$$

But it has been shown that any alteration in the resistance of a branch is equivalent to an alteration in its E.M.F., hence any alteration in the value of b can produce no effect on C_a or $\Sigma\, \frac{e_x}{R_{xa}}$ is independent of the value of b, that is to say, R_{xa} is independent of b when a and b are conjugate.*

As an example of the above the problem of finding the best resistance to give to the galvanometer in a bridge test is taken.



The current through the galvanometer or

$$C_g = \frac{E_g + K}{R_{gg}}.$$

Now $E_g = 0$ and $R_{gg} = G + R_g$; where R_g is the resistance external to the galvanometer, and therefore independent of the value of G.

Hence
$$C_g = \frac{K}{G + R_g}.$$

Now, the deflection is proportional to $C \times \sqrt{G}$ that is to

$$\frac{K}{\sqrt{G} + \frac{R_g}{\sqrt{G}}},$$

and this is to be a maximum which is the case when $\sqrt{G} = \frac{R_g}{\sqrt{G}}$, or $G = R_g$. That is, the galvanometer should have its resistance equal to the resistance external to it.

Now, when there is a balance F and G are conjugate, and the resistance external to G is independent of F, which may therefore be supposed to equal infinity. In

* For further particulars readers are referred to Mr. Sumpner's paper which was read before the City and Guilds of London Institute Old Students' Association, and a copy of which is to be found in the *Electrical Engineer*, February 24th, 1888.

this case $R_g = \frac{(A + B)(C + D)}{(A + B) + (C + D)}$, that is, the galvanometer resistance must equal the joint resistance of the branches in parallel with it, the battery resistance being supposed to be infinite.

SIMPLE ELECTRIC MOTOR.

IT is generally understood that an efficient electric motor cannot be made without the use of machinery and fine tools. It is also believed that the expense of patterns, castings, and materials of various kinds required in the construction of a good electric motor is considerable. The little motor shown in the engravings was devised and constructed (writes Geo. M. Hopkins in the *Scientific American*) with a view to assisting amateurs and beginners in electricity to make a motor which might be driven to advantage by a current derived from a battery, and which would have sufficient power to operate an ordinary foot lathe or any light machinery requiring not over one man power.

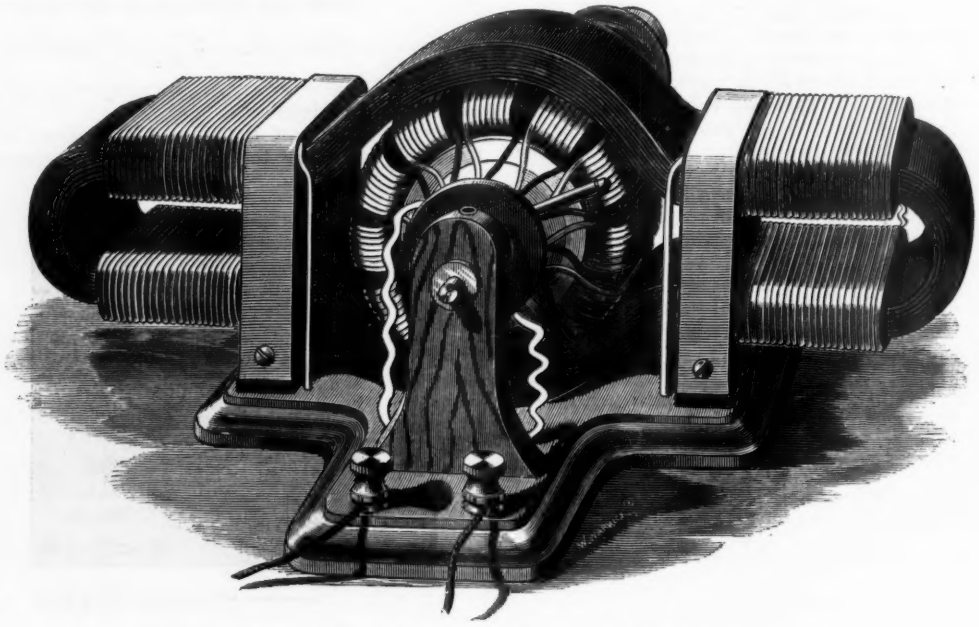


FIG. 1—SIMPLE ELECTRIC MOTOR (ABOUT HALF SIZE).

The only machine work required in the construction of the motor illustrated is the turning of the wooden support for the armature ring. The materials cost less than four dollars, and the labour is not great, although some of the operations, such as winding the armature and field magnet, require some time and considerable patience. On the whole, however, it is a very easy machine to make, and if carefully constructed will certainly give satisfaction.

Only such materials as may be procured anywhere are required. No patterns or castings are needed.

Beginning with the armature, a wooden spool, A (fig. 2), should be made of sufficient size to receive the soft iron wire of which the core of the armature is formed. The wire, before winding, should be varnished with shellac and allowed to dry, and the surface of the spool on which the wire is wound should be covered with paper to prevent the sticking of the varnish when the wire is heated, as will presently be described. The size of the iron wire is No. 18 American wire gauge. The spool is $2\frac{3}{16}$ inches in diameter in the smaller part and 2 inches in length between the flanges. It is divided at the centre and fastened together by screws. Each part is tapered slightly to facilitate its removal from the wire ring. The wire is wound on the spool to a depth of $\frac{3}{8}$th inch. It should be wound in even layers, and when the winding is complete the spool and its contents should be placed in a hot oven and allowed to remain until the shellac melts and the convolutions of wire are cemented together. After cooling, the iron wire ring, B, is withdrawn from the spool, and covered with a single thickness of adhesive tape, to insure insulation.

The ring is now spaced off into twelve equal divisions, and lines are drawn around the ring transversely, dividing it into twelve equal segments, as shown in fig. 3. Two wedge-shaped pieces, C, of hard wood are notched and fitted to the rings so as to inclose a space in which to wind the coil. This coil consists of No. 16 cotton-covered copper magnet wire, four layers deep, each layer having eight convolutions. The end, *a*, and the beginning, *b*, of the winding terminate on the same side of the coil. The last layer of wire should be wound over two or three strands of shoe thread, which should be tied after the coil is complete, thus binding the wires together. When the first section of the winding is finished, the wire is cut off and the ends (about two inches in length) are twisted together to cause the coil to retain its shape. After the completion of the first section, one of the pieces, C, is moved to a new position and the second section is proceeded with, and so on until the 12 sections are wound. The coils of the ring are then varnished with thin shellac varnish, the varnish being allowed to soak into the interior of the coils. Finally

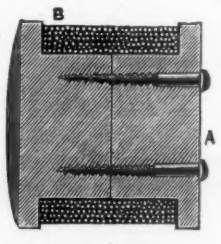


FIG. 2.—ARMATURE CORE.

the ring is allowed to remain in a warm place until the varnish is thoroughly dry and hard.

Care should be taken to wind all of the coils in the same direction, and to have the same number of convolutions in each coil. A convenient way of carrying the wire through and around the ring is to wind upon a small ordinary spool enough wire for a single section, using the spool as a shuttle.

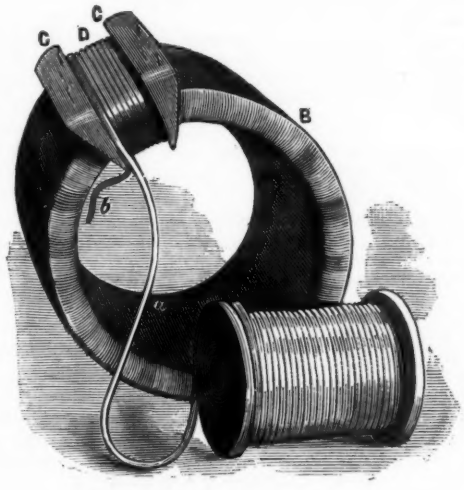


FIG. 3.—WINDING THE ARMATURE.

The ring is mounted upon a wood support or hub, G, and is held in place by the wooden collar, H, both hub and collar being provided with a concave flange for receiving the inner edges of the ring. The collar, H, is fastened to the end of the hub, G, by ordinary brass wood screws. Both hub and collar are mounted on a $\frac{9}{32}$nd steel shaft formed of Stubs's wire, which needs no turning. A pulley is formed integrally with the collar, H. The end of the hub, G, which is provided with a flange, is prolonged to form the commutator, and the terminals, *a b*, of the ring coils are arranged along the surface of the hub and inserted in radial holes drilled in the hub in pairs. The wires are arranged so that one hole of each pair receives the outer end of one coil and the other hole receives the inner end of the next coil, the extremities of the wire being scraped before insertion in the holes. The distance between the holes of each pair is sufficient to allow a brass wood screw to enter the end of the hub, G, and form an electrical contact with both wires of the pair, as shown in fig. 4.

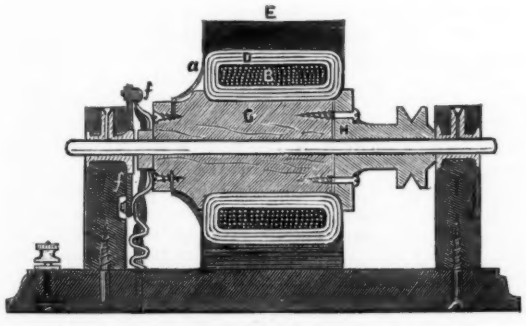


FIG. 4.—TRANSVERSE SECTION.

There being 12 armature sections and 12 pairs of terminals, there will, of course, be required a corresponding number of brass screws. These screws are inserted in the end of the hub, G, so as to come exactly even with the end of the hub. This completes the armature and the commutator.

Before proceeding to mount the armature shaft in journal boxes it will be necessary to construct the field magnet, as the machine must, to some extent at least, be made by "rule of thumb."

The body, E, of the field magnet consists of strips of Russia iron, such as is used in the manufacture of stoves and stove pipe. The strips are $2\frac{1}{2}$ inches wide, their combined length being sufficient to build up a magnet core $\frac{7}{16}$ths inch thick, of the form shown. The motor illustrated has 15 layers of iron in the magnet, each requiring about 26 inches of iron, approximately 33 feet altogether.

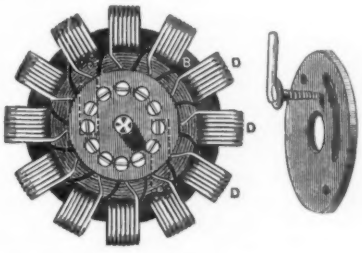
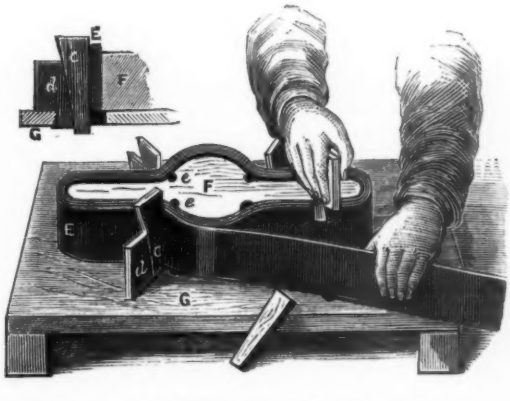


FIG. 5.—END VIEW OF ARMATURE, SHOWING COMMUTATOR.
FIG. 6.—BRUSH-HOLDING DISC.

The wooden block, F, on which the magnet is formed is secured to a base board, G, as shown in fig. 7, and grooves are made in the edges of the block, and corresponding holes are formed in the base to receive wires for temporarily binding the iron strips together. Opposite each angle of the block, F, mortises are made in the base board, G, to receive the keys, *d*, and wedges, *c*. Each key, *d*, is retained in its mortise by a dovetail as shown in fig. 8. By this arrangement each layer of the strip of iron may be held in position, as the formation of the magnet proceeds, the several keys, *d*, and wedges, *c*, being removed and replaced in succession as the iron strip is carried around the block, F. When the magnet has reached the required thickness the wedges, *c*, are forced down so as to hold the iron firmly, then the layers of iron are closely bound together by iron binding wire wound around the magnet through the grooves, *e*, and holes in the base board, G.

The next step in the construction of the machine is the winding of the field magnet. To ensure the insulation of the magnet wire from the iron core of the magnet the latter is covered upon the parts to be wound by adhesive tape or by cotton cloth attached by means of shellac varnish.



FIGS. 7 & 8.—FORMING THE FIELD MAGNET.

The direction of winding is clearly shown in fig. 9. Five layers of No. 16 magnet wire are wound upon each section of the magnet, the winding of sections 1 and 2 being oppositely arranged with respect to each other. In like manner the winding sections 3 and 4 are oppositely arranged. The winding of section 1 is also oppo-

site to that of 3, and that of 2 is opposite to that of 4. The winding begins at the outer end of the magnet, and ends at the inner end of the section. When the winding is completed the temporary binding is removed. The outer ends of 1 and 2 are connected together, and the outer ends of 3 and 4 are connected. The inner ends of 2 and 4 are connected. The inner end of 3 is to be connected with the commutator brush, *f*. The inner end of 1 is to be connected with the binding post, *g'*, and the binding post, *g*, is to be connected with the commutator brush, *f'*.

The field magnet is now placed upon a base having blocks of suitable height to support it in a horizontal position. A block is placed between the coils to prevent the top of the magnet from drawing down upon the armature, and the magnet is secured in place by brass straps, as shown in fig. 1.

The armature is wrapped with three or four thicknesses of heavy paper, and inserted in the wider part of the field magnet, the paper serving to centre the armature in the magnet. The armature shaft is levelled, and arranged at right angles with the field magnet. The posts in which the armature shaft is journalled are bored transversely larger than the shaft, and a hole is bored from the top downward, so as to communicate with the transverse hole. To prevent the binding of the journal boxes the exposed ends of armature shaft are covered with a thin wash of pure clay, and allowed to dry. The posts are secured to the base, with the ends of the armature shaft received in the transverse holes. Washers of pasteboard are placed upon the shaft on opposite sides of the posts, to confine the melted metal, which is to form the journal boxes. Babbitt metal, or, in its absence, type metal, is melted and poured into the space around the shaft through the vertical hole in the post. The journal boxes thus formed are each provided with an oil hole, extending from the top of the post downward. If, after cleaning and oiling the boxes, the shaft does not turn freely, the boxes should be reamed or scraped until the desired freedom is secured.

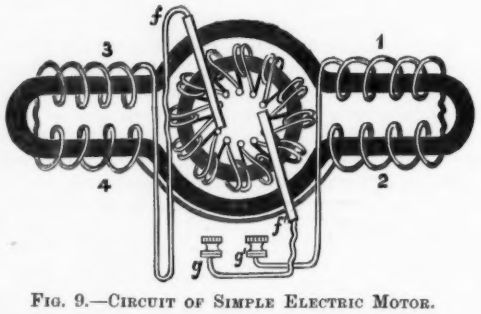


FIG. 9.—CIRCUIT OF SIMPLE ELECTRIC MOTOR.

All that is now required to complete the motor is the commutator brushes, *f*, *f'*. They each consist of three or four strips of thin hard rolled copper, curved as shown in fig. 4, to cause them to bear upon the screws in the end of the hub, G. The brushes are secured by small bolts to a disc of vulcanised fiber, or vulcanite, at diametrically opposite points, as shown in dotted lines in fig. 5, and the brushes are arranged in the direction of the rotation of the armature. In the brush-carrying disc is formed a curved slot for receiving a screw, shown in fig. 6, which passes through the slot into the post and serves to bind the disc in any position. The disc is mounted on a boss projecting from the inner side of the post concentric with the armature shaft. The brushes are connected up by means of flexible cord as shown in figs. 1 and 9. The most favourable position for the brushes may soon be found after applying the current to the motor. The ends of both brushes will lie approximately in the same horizontal plane. When the motor is in operation the direction of the current in the conductor of the field magnet is such as to produce consequent poles above and below the armature.

Eight cells of plunging bichromate battery, each having one zinc plate 5 × 7 inches, and two carbon plates of the same size, will develop sufficient power in the motor to run an ordinary foot lathe or two or three sewing machines.

The dimensions of the parts of the motor are tabulated below :—

Length of field magnet (inside)	10½	inches.
Internal diameter of polar section of magnet ...	3⅜	„
Width of magnet core	2½	„
No. of layers of wire to each coil of magnet ...	5	
No. of convolutions in each layer	34	
Length of wire in each coil (approximate)	95	feet.
Size of wire, Am. W. G.	No. 16	
Outside diameter of armature	3¼	inches.
Inside diameter of armature core	$2\frac{3}{16}$	„
Thickness „ „ „	⅜	„
Width „ „ „	2	„
„ „ „ (wound)	2½	„
No. of coils on armature	12	
No. of layers in each coil	4	
No. of convolutions in each layer	8	
Length of wire in each armature coil (approximate)	30	feet.
Size of wire on armature, Am. W. G.	No. 16	
Length of armature shaft	7¼	inches.
Diameter of armature shaft	$\frac{9}{32}$	„
„ „ wooden hub	1¾	„
Distance between standards	5½	„
Total weight of wire in armature and field magnet	6 lb.	

ELECTROLYSIS OF LEAD SALTS.

By ALEXANDER WATT.

(*Continued from page* 357.)

15. *Cyanide of Lead.*—Solutions of this salt were prepared in various ways, the object being to obtain a bath containing a fair proportion of the metal. In the first experiment a strong and hot solution of cyanide of potassium was first prepared, and to this was added, a little at a time, recently precipitated and moist protoxide of lead, the whole being well stirred after each addition. The liquid was then heated to below boiling point, and then allowed to cool. On decanting the clear liquor, it was found that the cyanide had acted but little upon the lead oxide, the greater portion of which remained untouched at the bottom of the vessel. The solution was then electrolysed with the current from a single Daniell cell, but no deposit could be obtained; three cells were then connected in series, when a bright film of lead of a pale bluish tint at once formed on a brass plate. The anode became coated with a golden yellow film of peroxide. A solution was next prepared by digesting moist carbonate of lead in a hot solution of cyanide of potassium, which became more freely dissolved than the protoxide. The clear liquor resulting from this combination was then tried with a single cell, but as no deposit was obtained the current from three cells was tried, when a film of lead of a dull grey colour slowly formed upon a brass cathode, which was very adherent. Gas was liberated at both poles, and the anode assumed a deep brown colour. A third solution was next formed by digesting finely powdered litharge in a strong hot solution of cyanide, from which a more satisfactory bath was obtained than from either of the preceding. When cold, the clear liquor was decanted, and electrolysed with a single Daniell cell, when a very prompt deposit of lead, of very good colour and perfectly bright, was obtained, and retained this character for a considerable time, and only became slightly dull after nearly an hour's immersion of the plate. The surface of the anode—which was always cleaned after each experiment—assumed a bright golden yellow colour in each of the foregoing trials. The deposit on the cathode was very adherent, and there was no evolution of gas at either electrode. The current from two and three cells, respectively, was subsequently tried with decreased anode surface, but while the rate of deposit was increased, the metal deposited of a somewhat darker colour and less bright than when a single cell only was

employed. We all know how greatly the colour of electro-deposited gold is influenced by the nature and condition of the electrolyte, density of current and temperature of the bath, the colour often ranging from pale straw colour to deep orange red. So, also, is the tone of this metal influenced by similar conditions, and it seems that the cyanide solutions of lead are capable of yielding exceptionally good deposits, so far as the colour of the film and its tenacity are concerned, but with these exceptions, the cyanide lead baths would appear to have no practical significance.

16. *Chloride of Lead in Caustic Potassa.*—To prepare a bath from this combination, a strong solution of caustic potash was heated to about 200° F., when crystals of chloride of lead were gradually introduced, and the mixture stirred after each addition of the lead salt. Soon after the materials had reacted upon each other a mixture of red and white precipitates was formed, but these eventually became almost entirely re-dissolved when the liquid was again heated. The solution was then allowed to settle and cool, after which it was decanted, and the clear liquor diluted and electrolysed with the current from a single Daniell, when a very quick deposit of a dull grey colour was obtained. A further addition of water was then given, when the deposition was more gradual, and the film upon a fresh plate became somewhat brighter and of better colour. After a short immersion of the several plates, the anode became coated with a film of peroxide of a nearly black colour.

17. *Iodide of Lead in Caustic Potassa.*—An attempt was made to dissolve iodide of lead in a hot solution of cyanide of potassium, for which purpose recently precipitated and moist iodide of lead was added to a hot solution of the cyanide, the action of which changed the colour of the lead salt from its golden yellow tint to a light grey colour, but without dissolving any appreciable quantity of the salt. A strong solution of potash was then added, and the liquid heated, when the grey product at once became dissolved. The solution was then allowed to become cold, after which it was electrolysed with the current from a single Daniell cell, when a bright deposit of lead was promptly received upon a brass plate, the film being of a light grey colour and tolerably bright. It was next determined to treat the iodide of lead with a solution of caustic potash direct, for which purpose a strong solution of potash was taken, and to this was added gradually iodide of lead, and the whole well stirred, when the lead salt became readily dissolved, forming a colourless solution. With the current from one cell, a quick but somewhat patchy deposit of a steel grey colour was obtained upon a brass plate, which was very adherent. The solution was next diluted, when the deposit became more uniform and brighter. A further addition of water was next given, when the deposition progressed more slowly, and the film appeared only in patches. To modify this, a second battery cell was connected, and the anode surface reduced, which had the effect of rendering the deposit more uniform. After a short time a lemon-yellow deposit formed upon the lead anode, which did not dissolve in the free potash present in the liquid, but deposited at the bottom of the vessel. After about half-an-hour's immersion of the plate the film assumed a slightly spongy character at the lower surface and edges of the plate.

18. *Sulphocyanide of Lead.*—A bath was prepared by digesting moist carbonate of lead in a hot solution of sulphocyanide of potassium, in which a moderate portion only of the carbonate became dissolved. The solution was then set aside until cold, when the clear liquor was decanted and electrolysed with the current from a single Daniell. In about half a minute after immersion, a brass plate became slightly coated with lead, on its upper surface only. Three cells were next tried, when a bright film of the metal at once took place on both sides of the cathode, but this soon after assumed a dull grey colour. On examining the anode, it was found that an opaque white deposit had formed on each side of that electrode. The lead film obtained in this experiment was thoroughly adherent.

19. *Pyrophosphate of Lead.*—A solution was prepared by digesting moist carbonate of lead in a hot solution of pyrophosphate of soda, in which a small portion only of the carbonate became dissolved. The solution being allowed to cool, was then poured off and electrolysed, first with a single Daniell cell, but no deposit was obtained upon a brass cathode. Three cells in series were next tried, when a bright film, of a pale bluish-gray tint, quickly formed upon a newly-prepared plate, the electrode surfaces being about equal. The solution was next moderately heated, and the anode surface diminished, when deposition took place more rapidly; there was, however, vigorous evolution of gas at both poles, while the anode assumed a golden yellow colour.

20. *Tartrates of Lead and Potassa.*—A bath was prepared by digesting recently-precipitated carbonate of lead in a boiling solution of cream of tartar, the mixture being continually stirred for some minutes. The clear liquor, when cold, was first tried with the current from one Daniell cell, but no deposit of metal was obtained. Three cells, in series, were next used, when a very light grey film promptly formed upon a brass plate, but gradually became darker, while gas was freely liberated at both electrodes. The current from two cells was subsequently tried, when the character of the deposit improved, being of a pale bluish-white colour, and very adherent, while there was but little gas evolved.

21. *Salicylate of Lead.*—A boiling solution of salicylic acid was first prepared, into which moist carbonate of lead was gradually introduced, the mixture being kept at the boiling point to prevent the re-crystallisation of the acid. As each portion of the carbonate of lead was added it became instantly dissolved, forming a pink solution; a few moments after, however, pink flocculent crystals formed and rapidly deposited at the bottom of the vessel; these crystals, however, some became re-dissolved when the liquid was heated to the boiling point. The solution thus obtained was allowed to cool down a little, and was then poured off from the crystals which formed during the cooling; the clear liquid was then electrolysed with the current from one Daniell cell, but no deposit resulted. Two cells were next used, when a bright, but non-adherent film was at first obtained, which, however, gradually became darker in colour and somewhat spongy. On examining the anode it was found to be covered with white clots of a gelatinous character, while the surface of this electrode appeared to have been somewhat freely acted upon. The solution was again tried on the following day—by which time a further deposit of pink crystals had become precipitated—when a bright and nearly white deposit of lead was obtained upon a brass plate with the current from two Daniells. The pink crystalline deposit of salicylate of lead before referred to was afterwards treated with caustic potash, in which the salt readily dissolved, and the resulting solution was then worked with the current from one Daniell, when a very quick and white deposit of lead was at first received upon a brass plate; this, however, became of a dull bluish-grey colour after a few minutes. The solution was then considerably diluted with water and a fresh plate immersed, which at once received a bright deposit as before. The solution, which at this time was in an exceedingly weak condition, still yielded a very prompt deposit of the metal with small anode surface (about one-eighth that of the cathode), and the film, while assuming a dull bluish colour on the surface, was readily brightened by rubbing with a wet finger. A solution of the salicylate of lead, prepared as above, yields up its metal so readily that with the current from a single Daniell cell, and an anode surface of not more than one-quarter of a square inch, a brass plate nearly two square inches became readily coated on both sides. It was noticed that a dark brown deposit formed upon the anode during the electrolysis of the foregoing solution, while there was no evolution of gas at either electrode.

22. *Hyposulphite of Lead.*—A hot solution of hyposulphite of soda was first prepared, to which was added some freshly precipitated and moist carbonate

of lead, the whole being afterwards well stirred and heated to near the boiling point. The solution was then allowed to cool and settle, when the clear liquor was poured off, and electrolysed with the current from a single Daniell cell. Soon after immersing a brass plate, a brownish film appeared on its surface, which, when rubbed with the finger, readily became removed, exposing a film of metallic lead beneath. Two cells were next tried, when the plate, as before, became coated with a loose brown deposit, which in a few minutes became very copious, and, falling from the cathode, settled at the bottom of the depositing vessel. When this brown layer was wiped off the plate, a reguline film of lead was found to have attached itself to the surface beneath. In this experiment it was somewhat remarkable that while the deposit in each case appeared in the first instance as a brown film of a non-metallic character, that when this was rubbed with the finger a white film of metal appeared beneath; indeed it was not until the brown layer had been rubbed that any evidence of a metallic deposit could be noticed.

23. *Sulphate of Lead in Caustic Potassa.*—A quantity of moist sulphate of lead was added to a strong solution of caustic potash, in which, with stirring, it readily dissolved. The concentrated solution was afterwards diluted with water, and then allowed to settle, when the clear liquor was decanted and electrolysed with the current from a single cell. On immersing a freshly prepared brass plate, a bright film of lead, of very good colour was at once obtained, and the deposit retained this character for many minutes, but after about a quarter of an hour or so the film became slightly dull, beyond which but little alteration was noticed until after the plate had been in the bath for nearly an hour, when a spongy deposit appeared, in patches or lumps, on the lower surface of the plate. On examining the lead anode there was a slight layer of loose matter, of a grey colour, on its surface, but when this was removed with the finger the metal beneath was perfectly clean. The current from two cells was next tried, when it was found that the deposit became at once dark-coloured and dull. After the plate had been in the bath a few minutes it was gently rubbed, when the dark deposit became removed, exposing a bright film of adherent metal beneath. The anode, which had become nearly black, was found to be coated with a grey powder, which was easily rubbed off, while the underlying black film was firmly adherent to the leaden surface.

24. *Basic Nitrite of Lead.*—A bath of this salt was obtained by boiling a strong solution of nitrate of lead with fine shavings of the metal, when a yellow solution was obtained. The liquid was next diluted with water, when it at once became turbid; a drop or two of nitric acid, however, soon rendered the liquor bright and clear. In the diluted state the bath contained about 60 grains of the salt in about 8 ounces of water. With the current from a single Daniell a very prompt and bright deposit of lead was obtained upon a brass plate, but this gradually became dull and darker in colour, more especially on one edge of the plate, and after about 20 minutes' immersion crystals of metallic lead formed on this part of the cathode and gradually extended towards the centre, while the opposite edge gradually assumed the same dark colour, succeeded by the formation of minute crystals. Thus, while this crystalline deposit occurred on both edges of the cathode, there was very little metal on the upper and lower surfaces of the plate. The film beneath the loose crystalline deposit was perfectly adherent. There was but little deposit on the back of the plate, and that only on the extreme edges.

25. *Citrate of Lead.*—A solution was prepared by adding peroxide of lead to a strong boiling solution of citric acid; the mixture of these substances was accompanied by vigorous effervescence, and after a few minutes' action the remaining lead oxide was converted into white protoxide. The liquid thus obtained had a yellowish tint, and became turbid when the boiling ceased, but on being re-boiled it at once became clear. The solution was next diluted with water and then allowed to cool, after which the clear liquor was decanted and electrolysed with the current from a single Daniell, when a very bright and white deposit of lead was received upon both sides of a brass plate. The film, however, became dull after a few minutes, from the formation of spongy metal. On examining the anode it was observed that white lumps of protoxide had formed on several parts of its surface, while a small quantity of the same substance slowly dropped from the plate and settled at the bottom of the vessel.

(*To be continued.*)

INDEPENDENT ENGINES FOR INCANDESCENT STATIONS.*

By WM. LEE CHURCH.

COMMERCIAL success in incandescent lighting depends primarily on the continuous, cheap, uniform, and flexible generation of power.

The service of electric lighting differs from other forms of manufacture in requiring more horse-power per square foot of floor space; in requiring higher speeds; in demanding the power in larger units; in compelling a closer and more uniform regulation; and in calling for more rapid and constant extensions. It will be observed that these peculiarities require individual and special treatment in the generation and distribution of power; and engineering practice as determined in other lines of manufacture may be sadly at fault when applied to electric machines.

It has become an axiom among experienced station managers that "the money is made or lost between the coal shovel and the belt." In other words, other things being equal, the dividend earning capacity of a station is determined by its steam plant, to which the electric apparatus is to that extent in the nature of an accessory.

Incandescent lighting has not until recently made a brilliant record as an investment, and much of the disappointment is directly traceable to the culpable ignorance of the principles of steam engineering which has been displayed. A man who will not venture to cut himself a two dollar vest will not hesitate to exercise his amateur talents on a steam plant, upon the economical and reliable performance of which depends an investment of $1,000,000 and the public service of a city. A long and critical experience in this branch of industry has grounded the conviction that no incandescent station can hope to be financially successful under the ordinary conditions of competition unless based on independent dynamos belted direct from independent engines. Throughout this paper, therefore, we desire to keep constantly in view the opposite systems, namely, a station containing a given number of dynamos of two or three different capacities, each belted direct from high speed engines of corresponding rating; and, on the other hand, the same station with the dynamos driven from one or two slow speed engines, transmitting their power through a line of countershafting and pulleys. Having these pictures well in mind, we inquire:—"What are the essential requirements of a first-class steam plant in an incandescent electric light station?" Taking them up in the order of their importance, we unhesitatingly say—first, and always foremost,

ABSOLUTE RELIABILITY FOR CONTINUOUS RUNNING.

The electric light company contracts to supply the demands of a diverse and exacting public, and that public expects to find its light on tap every moment in the year. Failure of service in ever so small a degree is palliated by no excuse. Complete reliability is the condition of popular confidence and patronage, without which all other economies and excellencies go for nothing.

Again, electric lighting perhaps more than any other industry has its earnings directly affected by the shutting down of its power, since it sustains a direct financial loss for lights out, aside from loss of custom and reputation, not easily regained. Subdivided power reduces this risk to a minimum, and properly directed and applied obviates it altogether. In a station using 2,000 H.P., say, in the shape of two large engines, the loss of income in one night by the shutting down of one of these engines is equal to one-half the cost of an independent engine on the subdivided plan. In other words, as tersely expressed by a manager of experience, a company might better for peace of mind, reputation, and cash balance on the books, throw a 60 H.P. engine into the scrap pile than to shut down the station for one hour. The service of electric lighting is similar to the editing of a daily paper in that lost time can never be regained. Most industries can make up lost time by working overtime and by pushing their business in various ways, but in electric lighting

> "The mill will never grind with the water that has passed."

Passing from argument to instance, we cite the recent experience of one of the largest stations in the country, operating in the

* Read before the American National Electric Light Association Pittsburg, February, 1888

neighbourhood of 20,000 lights. This station as originally planned was driven from a pair of Corliss engines, each having a cylinder 28 inches in diameter by 48 inches stroke, and belting to a countershaft 4½ inches in diameter by about 50 feet in length. From this countershaft are driven five dynamos, having an aggregate capacity of 6,000 16-C.P. lamps. Clutch pulleys 8 inches in diameter are the means of disconnecting the dynamos when not in service, with similar clutch pulleys for the exciters. The remaining dynamos in the station are each 2,500 lights capacity, and each are driven by a 200 H.P. independent engine, belted direct. Recently in the middle of the heavy run of the evening an accident occurred necessitating the immediate shutting down of the 6,000 lights, besides doing considerable damage, and involving danger to the *employes*. It happened that one of the engines with its dynamo was immediately available, and was started within two or three minutes, so as to take up a portion of the load of the large engine. In the same station, at a subsequent time, a key became loose on the valve gear of the engine, necessitating another stop for several minutes. On still a third occasion the crank pin became uncomfortably hot, and was carried through the run only at a great risk and labour. Illustration might be multiplied, but this is used as one among many of the almost evident facts that no electric light station can afford to hang its whole business upon any one source of motive power, particularly when that motive power is distributed through the complex mechanism of countershafting, involving risk of hot bearings, broken pulleys, defective frictions, and what not, any one of which may shut down the whole station. Had these same dynamos been each belted direct from an independent engine the accidents above enumerated could not have occurred in the nature of the case. We do not assume to say but that accidents of some nature are due in any piece of mechanism, but the division of power and generating capacity into comparatively small units, each independent of all the others, affords a practical means of distributing the danger, so that it is essentially *nil* in its effects. That is to say, had a stoppage of any one independent engine in a similar instance occurred from any cause, the other engines with their dynamos would easily have distributed the load for a short time without any disturbance or danger whatever, and the service would have been uninterrupted while the repairs were being made or the difficulties remedied.

It has been incidentally remarked in another paper that independent engines afford a safeguard against danger from short-circuits, inasmuch as the current due to the short-circuit will overload an independent engine and slow it down, thus giving warning of the danger. If the dynamo is driven from a single large engine, the motive power will not respond to the short-circuit until it becomes equal to the full capacity of all the connected dynamos, plus the range of power in the engine. Practically, therefore, a single slow speed engine will not feel the short-circuit, but will pull it through until something burns away.

That merit of the steam plant which is most obvious, and which appeals most strongly to the electric light company is, *economy of fuel*.

The advocates of large slow speed engines rely upon the supposed superior fuel economy of this type as the sole offset to its obvious disadvantages. All managers unhesitatingly admit the superiority of transmitting the power directly and without loss from the engines to the dynamos, and more or less readily concede that in its performance the high-speed engine will equal the running qualities and durability of the slow-speed engine. If with this, say they, we could get the steam efficiency of the Corliss type of engine, no man would hesitate to decide in favour of the convenient, compact, and independent small engine. We take the question at once by the beard, and desire to state that of two incandescent stations operating under ordinary circumstances, and otherwise equal, except only in their power and transmission, that one which has independent direct-belted engines will show in its monthly report sheet, not a small amount, but from one-quarter to one-third less coal per lamp hour, than the station driven from a single engine through countershafting, both types of engines being non-condensing. We go yet further, and state that independent non-condensing engines under certain conditions will about equal in economy an equivalent slow-speed condensing engine. This is a fact so incontrovertible when actually and candidly investigated, that we do not propose here to demonstrate but merely to illustrate it.

We now submit to the prompt inquiry:—"Will not a high-speed engine use more coal per horse-power than a Corliss engine?" Yes. "How much more?" Size for size and load for load not over 10 to 20 per cent. Score 10 per cent. against the high-speed engine, and again ask:—"Will not several small engines use more steam than one equivalent large engine even of the same type?" Yes. "How much more?" Load for load possibly another 10 per cent. Score 20 per cent. against the high-speed engine, and again ask:—"How an admitted loss of one pound of coal in every five can be reconciled with the statement of a monthly saving of 25 to 30 per cent. in favour of independent engines?" Answer: Simply because we have to deal with conditions as they exist in fact, and not as we assume them to exist.

The reason why independent engines can overcome their moderate lack of initial economy, and pass a large percentage of actual economy to their credit, are mainly two. First: The use of a countershaft implies power to run it. Indicator diagrams show that the dead load of such a plant varies from 12 to 20 per cent. of the gross horse-power under full load when in ordinarily good condition, and not infrequently rises to 30 per cent. and over with badly lined shaftings and badly drawing belts. Moreover, it must be borne in mind that the dead load is nearly a constant quantity, and if it amounts to 20 per cent. of the full load, it will under partial load equal and even exceed the net power transmitted to the dynamos. It may easily happen, every night in every station thus powered, that from midnight to morning two to three horse-powers are expended in the cylinder for each effective horse-power recovered at the dynamo pulley. Thus by one stroke and by a single item is the conceded advantage of the larger engines, reckoned in coal per horse-power, practically swept away, and large and small engines left standing on an equal footing, prepared to submit to the still more searching question:—"What is the cost from hour to hour of the power actually expended in meeting the fluctuation of the load?"

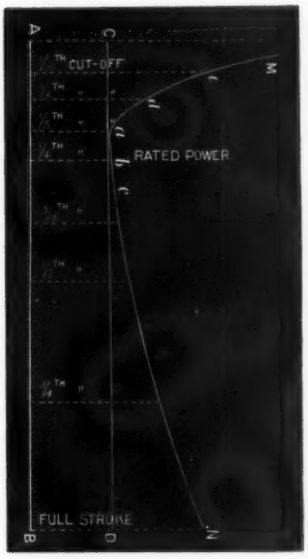


FIG. 1.

To consider for a moment some abstract facts in steam engineering, we must note that the steam engine develops its maximum economy (*i.e.*, minimum consumption) only over a limited range of its power. Under normal conditions of pressure, say, 80 to 100 pounds in the boiler, this minimum consumption is found only between the points of 1–5 and 1–4 cut off, say, from *a* to *b*, fig. 1, at which latter point all engines are now rated. At its rated power, therefore, the single large engines of the Corliss type will consume as little as 26 to 28 pounds of water (steam) actually fed to the boilers per indicated horse-power per hour, and if the economy were not affected by the load we could represent the rate of consumption by the straight line, C, D. If overloaded, however, the rate of water consumption rises as shown on the right-hand portion of the diagram, in which the horizontal distances represent the cut-off, and the vertical denominates the actual points of water consumption; the curve, therefore, being a curve of efficiency at varying loads. It will now be particularly noted that whereas the line rises for an overload, it also rises for an underload, and very much more rapidly. This is well understood to be partly from excessive condensation due to over-expansion, and partly from the greater percentage of leakage under short cut-offs. Considering fig. 1 to represent the actual performance of a 400 H.P. engine at varying points of cut-off, it will be seen that the engine will be at its best only over a limited range, from *a* to *c*, or, say, from 325 to 450 H.P. An overload is, of course, mechanically injurious, which limits the possibilities in that direction. As the load falls off below 1–5 cut-off the steam rate increases in an enormous ratio, so that at 200 H.P. the engine is using 50 per cent. more than its normal rate, *i.e.*, at 200 H.P. it is actually using the gross amount of steam which would give 300 H.P. if used in a 300 H.P. engine. At 100 H.P., the waste is fully 100 per cent., and the steam used should develop not 100 H.P., but 200 H.P., if used in a 200 H.P. engine. It must be borne in mind that the diagram is plotted from observation, and is not a diagram of theoretical deductions.

It now remains to determine if the conditions actually obtaining in electric lighting stations are such as will enable a single large engine to develop its normal economy; and if not, then are they such as will enable the smaller independent engine, with a lesser initial economy, to reach a better gross result under the inevitable conditions as they are found to exist.

The typical daily chart of ampères delivered from an incandescent station of say, 4,500 lights, is shown in fig. 2, of course with variations in different stations, but always of the same general character. The chart is assumed to cover a winter night's

run, commencing at 4 p.m., and shutting down at 8 a.m. The heavy irregular line, A B, represents the fluctuation of the actual load, such as would be determined by indicating a series of independent engines, and the area enclosed between it and the base line, M N, may be denominated the net power required. The fine irregular line, C D, encloses the gross load when driven by a single large engine, being equivalent to the net load plus the friction of the shafting and pulleys required in transmission. The irregular band lying between A B and C D, therefore, represents the dead load, which is a net loss, due to the friction of shafting.

But, as shown above, this is not the full measure of the loss. We have already seen in fig. 1 that an excessive underload requires a *relative* amount of steam which would be adequate to produce a much greater maximum efficiency. Combining the two diagrams, therefore, we would find a third dotted line, E F, which would clearly represent the actual steam consumption required to secure the network, A B. The irregular band, therefore, between A B and E F, represents the total loss expressed in coal. In other words, the entire area, E F, represents the lamps which should be got for the steam expended, whereas, E F M N represents the lamps actually got for the steam expended. The loss involved is practically 50 per cent. of the total fuel in the whole night's run, which corresponds to observed results in

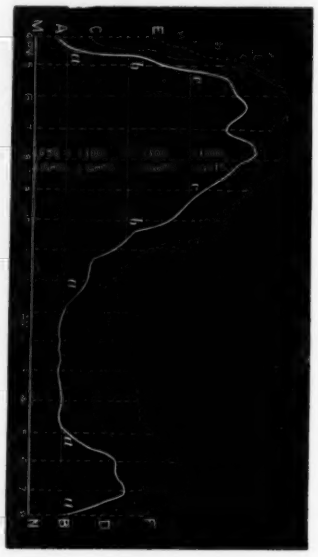


FIG. 2.

stations whose fluctuations of load are about as indicated. Of course, there are stations in which the net load averages more uniform than that shown, and a better proportionate result would, therefore, be expected from the single large engine with countershafting. We believe it safe to say, however, that there is no incandescent station which will get a load so constant as to secure the economy from a single engine equal to that which can be realised from subdivided power.

We now contrast the performance of independent engines in the same station. The lower narrow band between the lines, M N and *a a*, represents the smallest dynamo, or successive loads of 1,300 lights each. At starting time, therefore, a 60 H.P. engine with its 650 light dynamo is opened, and run continuously until shutting down in the morning. It will be noted that while running, the load on this engine is practically constant and at the point of maximum efficiency. In 10 minutes after starting, the load rapidly increasing, it becomes necessary to start the second 125 H.P. engine with its 1,300 light dynamo, which engine, again, runs on its full and most efficient load, as indicated between the lines *a a*, *b b*. This engine is stopped at 12.45, making another short run in the morning, and is, therefore, running to disadvantage for about an hour. At 4.40 the increase of lights calls for the third engine with its dynamo, which in turn runs until 10.45, and is then stopped. The point to be clearly understood as vital to the whole economic question, is, that each engine while running is loaded to its best efficiency, runs only so long as its load is called for, then stops altogether, and with it all consumption of steam, leakage, radiation, wear and tear, and loss of every nature. Ample time is given to inspect the engine and dynamo if necessary, and the system as a whole develops the last possibilities of commercial efficiency.

The above diagram practically represents the performance of two stations which we once had the privilege of comparing, both of which were of practically the same size and both constructed on the same electrical basis. We were by courtesy put in possession of the monthly reports from both these stations, which showed a ratio between the pounds of coal per ampère hour of 70 to 126 in favour of the station driven by independent engines. A station whose motive power is one or two large engines, therefore finds itself in a position of earning money between starting time and 10 o'clock, and spending it again between 10 o'clock and morning.

We have thus endeavoured to make it clear in the above illustrations that the rated economy of the two types of engines is but a small part of the consideration, and cuts practically no figure whatever in actual practice under the condition imposed by the nature of incandescent service.

If anyone is now unthinking enough to inquire:—Why not use a number of small Corliss engines in place of high speed engines, if it is admitted that the Corliss type is the more economical of the two?—we would answer, briefly:—First, small Corliss engines are not as economical as small single valve engines, the percentage of leakage due to the four valves and slower speed being much greater. Second, small engines of the Corliss type run necessarily at so slow a speed as to preclude the possibility of direct belting, and to involve full lines of countershafting, with their attendant cost and waste of power; Third, the first cost of small slow speed engines is very greatly in excess of that of high speed engines for the same power. We think no one has ever seriously considered, however, the adoption of small independent slow speed engines.

Next in importance to reliability and economy is *uniformity, delicacy and continuity of regulation.*

There is much misapprehension regarding the matter of regulation in engines used for electric lighting. Let us, therefore, ask:—What is good regulation? Good regulation implies, as a matter of course, reasonably small variation in speed, reckoned in R.P.M., between the engine fully loaded and the engine running light. Claims are made that such and such engines regulate to two per cent., one per cent., and even one-half of one per cent., under variations of load. Now, it should be clearly understood once for all, that any decent automatic engine controlled by a shaft governor can be so adjusted as to regulate, not merely to two per cent., or one per cent., but to actually pass the point of exact regulation and run faster under load than when light. So far as regulation in terms of R.P.M. is concerned, one per cent., or two per cent regulation is sufficiently close for all ordinary purposes.

Second.—The most important consideration in the regulation of engines in incandescent stations is not their variation from minute to minute, but *from stroke to stroke.* An engine may make 300 turns per minute, counting for each successive minute of the hour, and yet may at any given instant be running sensibly above or below this speed, in the effort to meet a momentary fluctuation of load. We say every engine may do this, and we have observed that most engines do do this frequently, the difficulty being, not a matter of the construction of the governor, but purely a question of lubrication. A perfect governor is one which will maintain the speed, not at an *average* of 300 R.P.M., but at the *rate* of 300 R.P.M. for each and every stroke. Any properly constructed governor will retain the average of regulation to which it is set, but it can only secure instantaneous regulation when friction is practically eliminated. It has been our experience that nothing but a complete bathing of the governor in oil will practically accomplish this purpose.

Incandescent lamps require a regulation more delicate, perhaps, than any other industry. Any departure in regulation from stroke to stroke gives a variation of E.M.F., which is speedily destructive to the life of the lamp, that item which, next to fuel economy, is the heaviest tax. The injury is done during the period of acceleration immediately following the change of load, which period is the time between the change of load and the movement of the governor, and this in turn is proportional to the friction. It is obvious that if friction were annihilated the acceleration would be also nil, and the speed, and consequently the E.M.F., would never vary.

Third.—Under the extremely long runs now imposed by electric light service, continuity of good regulation is essential. That is to say, a governor which will regulate when well oiled will fail to regulate when its pins and bearings, being inaccessible under motion, have become dry during a long run.

As to the nicety of regulation obtainable from a slow speed engine, there is no comparison possible. We have already shown that it is not permissible for an electric light engine to vary its speed even from stroke to stroke. All observers know that it is frequently quite possible to count the revolutions of a slow speed engine, particularly when heavily loaded, by the pulsations in the lamps at a distance from the station. A slow speed engine, unless excessive in its flywheel capacity, will imperceptibly slacken in passing its centres, and this variation not visible on the engine, becomes a sensible and dangerous variation when multiplied to the speed of the dynamo. The fluctuations of the needle of two voltmeters respectively registering from a high speed and slow speed engine will give abundant evidence on this point.

FLEXIBILITY.

The characteristic of flexibility in electric light stations is one which is frequently overlooked until experience, except in stations where the lowest dynamos is small enough for the minimum unit, demonstrates its desirability. To secure the best possibilities in this direction, it is necessary to use dynamos of two or three different sizes, each being driven direct from its independent engine. The plant being thus divided into independent units of

different sizes any variation of demand, either in the total load or in the load required for different circuits, can be conveniently met. Owing to local causes, the load of a station is not necessarily the same from day to day. It is obvious that a plant in which all the dynamos are hung upon one, or at most two, engines, is essentially rigid in its control of circumstances, whereas a station planned as above indicated, is to the last degree flexible in meeting any variation of load to whatever degree it may occur. All this has a direct bearing both on economy of fuel and incidentals of operation.

We would not wish to imply that the smallest unit in every station should necessarily be the smallest unit as determined by the minimum load existing for any considerable time during the day. This minimum load in the majority of medium sized stations will represent about one-eght to one-sixth the generating capacity of the station. That is to say, a station of 4,000 lights capacity should have one dynamo at least as small as 650 lights. Beyond this it is, perhaps, advisable that the units be uniform for the sake of interchangeability of parts. The whole question of units of generation must be considered, not in the light of any one rule, but under all the circumstances of each particular case.

Maintenance of Plant.

The maintenance account of a plant often defeats dividends. In the use of countershafting an entirely new factor of expense is introduced, pertaining to the shafting, bearings, pulleys, clutch pulleys, belts, &c.

Each bearing of the countershafting will consume oil to the value of at least five dollars per annum, and any considerable amount of shafting involves the pay of an extra oiler to properly care for it. Regarding the two types of engines under discussion, it is undoubtedly true that the maintenance of the high speed engine will be fully as low as of an equal horse-power in slow speeds, as to its direct expense, without taking into account the time lost in repairs. Nearly all the high-speed engines are made to gauge with more or less reference to interchangeability of parts. Repairs in consequence are furnished at a minimum of cost, and the parts being light and readily handled, the engine can be stripped, overhauled, and connected up, without the employment of an extra force of men, or the necessity for heavy handling. In referring to high-speed engines, we, of course, only speak of those which are carefully and understandingly designed for the work put upon them. That is, we wish to draw a sharp distinction between high-speed engines and engines speeded high.

The one danger of high-speed engines arises from the possibility of charging the cylinder with water which cannot be quickly enough relieved through the valve at the speed at which the piston travels. The fact that no engineer justly entitled to the name should ever allow an accident of this nature to happen, does not in the public mind shift the responsibility from the maker of the engine. Spring relief valves have now been brought to a state of perfection which leaves little to be desired, when the engine is of a type permitting their use.

Space Occupied.

This is one of the minor considerations which in certain locations becomes of considerable importance. Not infrequently electric light stations are located near the business portion of the city, where real estate is valuable, and taxes correspondingly high; and space counts heavily in the capitalised investment. Again, a large building obviously increases the investment, particularly when a building to carry heavy lines of shafting at high speeds must be of unusually massive construction. It needs no illustration to show that independent engines by doing away with the space occupied with countershafting and belts, under the least distance between centres which can be justified, require materially less space per horse-power than any form of non-subdivided power. This is particularly the case where the dynamos are placed on the second floor over the engine room.

Moreover, the cramped space in which the single engine must develop and distribute its power is against its satisfactory performance. The fact is generally overlooked in drawing comparisons, that a single large engine in an ordinary manufacturing establishment, such as a cotton mill, has in the nature of the case a wide space in which to transmit its power from the slow motions of the engines up to the high speed of the spindles. This means that ample space is given to bring the speed by gradual accelerations, through easy moving shafting of substantial nature, up to a moderately high intermediate speed, and then distribute it to the spindles in small quantities by means of simple, light, fast running devices. In the dynamo room, on the contrary, the space is cramped to the last degree, and the slow running engine must *in short range*, multiply its power to high velocities, and transmit its speed in large units to the dynamos. The whole system of transmission becomes rigid and ineffective, and the loss consequent upon friction, and risk to *employes*, and the magnitude of disaster when any occurs, are such as in themselves to overbalance all the economy which the most enthusiastic advocates of slow speed engines attribute to them.

Extension of Plant.

An electric light station, unlike most other industries, is usually of very rapid and persistent growth, to an extent which is not generally foreseen in the original calculations. The use of independent engines lends itself readily to indefinite extension. The power and dynamos both being divided into like units, each independent of all the others, extension becomes merely a question of more units, without any special preparation in the plan. On the other hand, the slow speed engine with countershafting is necessarily in large units, and to that extent fails to meet the requirements of a gradual increase. The use of the large engine involves an outlay disproportionate to the immediate returns from the first increase as ordinarily provided for, and it necessitates also the operation of the moderately increased plant at a great disadvantage on account of the underload involved, as already explained. The practical operator will readily see the force of this important advantage on the side of the independent engine.

First Cost of Plant.

This consideration, although really of the least importance among those enumerated, is distinctly on the side of subdivided power. The price of high-speed engines per horse-power is now fully as low, and generally lower, than that of slow-speed engines. Cost of foundations is materially less, as is also cost of erection and handling for repairs. There then comes into the question the clear saving of all the money invested in countershafting, pulley blocks, heavy belting, clutch pulleys, receiving pulleys, and similar devices. In the station to which we referred above the extra transmitting devices necessitated the investment of a sum not less than $6,500.

The price thus expended for worse than useless machinery would be sufficient to purchase practically 500 H.P. of independent engines, adequate to generate 6,000 lamps, showing a net earning capacity of at least $18,000 per annum.

When we contrast this with the net losses due to the system of concentrated power, as above discussed, it leaves no room for argument as to the advantage of independent engines in electric light work.

FIRE RULES.

Society of Telegraph-Engineers and Electricians.—Rules and Regulations for the Prevention of Fire Risks arising from Electric Lighting.

Revised and Remodelled from the Rules issued by the Society in 1883, *and from other sources of information, both home and foreign, and recommended by the Council in accordance with the Report of the Committee appointed by them to consider the subject.*

These General Rules are drawn up with the object of reducing to a minimum, in the case of the electric light, those risks of fire which are inherent to every system of artificial illumination, and also for the guidance of those who possess, and those who contemplate having, electric lighting apparatus on their premises.

It is to be understood that these General Rules are not intended to supersede any Detailed Rules which fire offices may issue for their own protection

It would therefore be desirable that before the electric light is used, notice should be sent to the fire office in which the building is insured, in order that an opportunity may be given for inspecting the installation.

The chief difficulties which beset the electrical engineer are internal and invisible, and they can only be effectually guarded against by testing with special apparatus and electric currents; they arise from leakage and from bad connections and joints, which lead to waste of energy and the production of heat to a dangerous extent.

In addition, the difficulties arising out of defective and inefficient apparatus are numerous; they must be understood and guarded against.

The necessity cannot be too strongly urged for guarding against the presence of moisture, which leads to loss of current and to the destruction of the conductors and apparatus by corrosion and otherwise.

Injudicious connections of any part of the circuit with the "earth" tend to magnify every other source of difficulty and danger.

Many of the dangers in the application of electricity arise from ignorance and inexperience on the part of those who supply and fit up inadequate plant, and frequently from injudicious economy on the part of the user.

The greatest element of safety is, therefore, the employment of skilled and experienced electrical engineers to specify the method in which the work is to be done and the quality of the materials to be employed, and to supervise the execution of the work.

Conductors.

1. They must have a sectional area and conductivity so proportioned to the work they have to do that, if double the current proposed is sent through them, the temperature of such conductors shall not exceed 150° F.

2. The conductors, or their casings, should be placed in sight if possible; and they should always be as accessible as circumstances will permit.

3. Within buildings they should all be insulated; and this rule applies equally to all conductors and parts of fittings which may have to be handled.

4. Whatever insulating material is employed, it should not soften until a temperature of 170° F. has been reached, and in all cases the material must be damp-proof.

5. When leads pass through roofs, floors, walls, or partitions, and where they cross or are liable to touch metallic substances, such as bell wires, iron girders, or pipes, they should be thoroughly protected by suitable additional covering; and where they are liable to abrasion from any cause, or to the depredations of rats or mice, they should be encased in some suitable hard material.

6. In the case of portable fittings with which flexible leads are used, special precautions must be taken.

7. Conductors should be kept as far apart as circumstances will permit, the spacing between them being governed by their potential difference.

8. When conductors are carried in very inflammable structures, precautions should be taken to isolate them therefrom.

9. Conductors which are protected on the outside by lead, or metallic armour of any kind, require the greatest care in fixing, on account of the large conducting surface which would become connected to the core in the event of metallic contact between them.

10. In cases where conductors pass into a building, from one building to another, or from one room to another, precautions should be taken to prevent the possibility of fire or water passing along the course of the conductors.

11. All joints must be mechanically and electrically perfect, to prevent heat being generated at these points. When soldering fluids are used in making joints, the latter should be carefully washed and dried before insulation is applied.

12. Under all circumstances complete metallic circuits must be employed. Gas and water pipes must never form part of the circuit, as their joints are rarely electrically good, and therefore become a source of danger.

13. Overhead conductors, whether passing over or attached to buildings, must be insulated at their points of support. Precautions must be taken to obviate all risk of short-circuiting where they are likely to touch a building or other overhead conductors and wires, either by their own falling or being fallen upon by other conductors.

14. In the case of overhead wires, every main should have a lightning protector at each point where it enters or branches into a building.

15. Metal fastenings for fixing conductors should be avoided; but, when unavoidable, some additional covering should protect the conductor from mechanical injury at such fixing points.

16. The insulation of a system of distribution should be such that the greatest leakage from any conductor to earth (and, in case of parallel working, from one conductor to the other, when all branches are switched on, but the lamps, motors, &c., removed), does not exceed one five-thousandth part of the total current intended for the supply of the said lamps, motors, &c.; the test being made at the usual working electromotive force.

17. It will often be found a great convenience and assistance in the prevention of accidents if the positive lead be coloured differently to the negative, or made otherwise distinguishable.

SWITCHES.

18. Every switch or commutator should be of such construction as to comply with the following condition, namely—That, when the handle is moved or turned to and from the positions of "on" and "off," it is impossible for it to remain in any intermediate position, or to permit of a permanent arc, or heating.

19. The handles of every switch must be completely insulated from the circuit.

20. The main switches of a building should be placed as near as possible to the point of entrance of the conductors, or to the generators of the current if they are within the building itself. Switches should be provided on both leads.

21. Switch-boards should bear clear instructions for their use by the inexperienced.

ELECTRICAL FITTINGS GENERALLY.

22. Switches, commutators, resistances, bare connections, lamps, &c., must be mounted on incombustible bases. Cut-outs mounted on bases of wood rendered uninflammable are admissible. Vulcanite bases are undesirable in damp situations. The cracking of porcelain and earthenware fittings is a source of danger which can be avoided by precautions in fixing.

CUT-OUTS.

23 All circuits should be protected with cut-outs; and all leads from the mains, or small conductors from larger ones, must be fitted with cut-outs at their branching points.

24. Where fusible cut-outs are used the section should be so situated within its frame that the fused metal cannot fall where it may cause a "short-circuit" or an ignition.

25. For all main conductors a cut-out should be provided for both the "flow" and "return," and the two fusible sections must not be in the same compartment.

26. The flexible leads of portable fittings must in all cases be protected by cut-outs at their fixed points of connection.

ARC LAMPS.

27. Arc lamps must always be guarded by lanterns or netted globes, so as to prevent danger from ascending sparks and from falling glass and incandescent pieces of carbon.

28. All parts of the lamps and lanterns which are liable to be handled (except by the persons employed to trim them) should be insulated.

THE DYNAMO.

29. The armatures and field-magnet coils should be thoroughly insulated. Dynamos should always be fixed in dry places, and they must not be exposed to dust flyings or other industrial waste products carried in suspension in the air. They should not be permitted in the working-rooms of mills, where the liability to such dangers exists, or where any inflammable manufactures are carried on or inflammable materials are stored.

30. Motors should be subject to the same conditions; but when it is necessary to use them in positions such as those above referred to they must be securely cased in, such cases having a non-combustible lining.

BATTERIES.

31. Both primary and secondary batteries should be placed and used under the same precautions as prescribed for dynamos; and the room in which they are placed should be well ventilated. The batteries themselves must be well insulated.

TRANSFORMERS.

32. When these are used to transform either direct or alternating currents of high electromotive force—that is, from or to an electromotive force of, say, 200* volts—they, together with their switches and cut-outs, must be placed in a fire and moisture-proof structure—preferably outside the building for which they are required. No part of such apparatus should be accessible except to the person in charge of their maintenance.

33. In all cases conductors conveying currents of high electromotive force inside buildings must be specially and exceptionally insulated, cased in, and the casing made fire-proof.

34. The positive and negative terminals connected to such conductors should not be permitted to be nearer each other than 12 inches.

35. Transformers which, under normal conditions of load, heat above 150° F., should not be permitted to remain in use.

36. Transformers should be so constructed that under no circumstances whatever should a contact between the primary and secondary coils lead the high E.M.F. into the building.

MAINTENANCE.

37. The value of frequently testing and inspecting the apparatus and circuits cannot be too strongly urged as a precaution against fire. Records should be kept of all tests, so that any gradual deterioration of the system may be detected.

38. Cleanliness of all parts of the apparatus and fittings is essential to good maintenance.

39. No repairs or alterations must be made when the current is "on."

All the above rules, for the reduction to a minimum of the risks from fire, are also applicable in principle to installations of electricity for other uses than that of lighting; they also include precautions necessary to avoid risk of injury to persons, whether the conductors and apparatus are situated inside or outside a building.

By order of the Council,
F. H. WEBB, *Secretary*.

Offices of the Society, 4, The Sanctuary,
Westminster, *April*, 1888.

RULES AND REQUIREMENTS OF THE NEW ENGLAND INSURANCE EXCHANGE FOR ELECTRIC LIGHTING BY THE ARC SYSTEM.

THE following has been adopted from March 1st, 1888, by the N. E. Insurance Exchange, and superseding all previous rules relating to arc lighting:—

OUTSIDE WIRES.

1. All outside overhead wires must be covered with some material of high insulating power, not easily abraded, and impervious to moisture; and they must be firmly secured to properly insulated and substantially built supports. All tie wires must be insulated the same as conducting wires.

2. All joints must be so made that a perfectly secure and unvarying connection, fully equal to the cross-section of the conducting wire, will be secured, and they should be soldered. Resin must not be used as a flux. Nothing stronger than a 10 per cent. acid solution should be used, and any excess should be washed off before the splice is covered. This also applies to inside wires. All joints must be securely wrapped with at least five layers or ply of an approved tape.

3. Care must be taken that conducting wires are not placed in such position that it would be easy for water, or any liquid, to form cross-connection between them, and they should not approach each other nearer than one foot.

4. The wires must never be allowed in contact with any substance other than air, and their proper insulating supports.

5. Conducting wires carried over or attached to buildings, *must* be at least 7 feet above the highest point of flat roofs, and 1 foot above the ridge of pitch roofs. Lines constructed subsequent to the adoption of these regulations should not be run over and attached to buildings other than those in which the light or power is being, or is to be used, but should be on separate poles, where they can be easily reached for inspection.

6. When they are in proximity to other conducting wires, or any substance likely to divert any portion of the current, *dead*,

* Can this be intended for 2,000 volts?—EDS. ELEC. REV.

insulated guard-irons must be placed so as to prevent any possibility of contact in case of accident to the wires, or their supports. The same precautions must be taken where sharp angles occur in the line wires, and also where any wires (telegraph, telephone, or others) could possibly, owing to their position, come in contact with the electric light wires.

7. Overhead wires from the main circuit or pole in the street to the terminal insulators attached to buildings, and at the point where they enter a building, must not be less than 12 inches apart. They must be rigidly and neatly run and supported by glass or porcelain insulators, or rubber hooks. The rubber hooks must be of an improved pattern, *i.e.*, with the rubber insulation free from flaws, and projecting over the hook in cup form.

8. Service blocks must be protected by at least two coats of waterproof paint over their entire surface, and when used to support rubber hooks, must have at least one inch of wood between the inner end of the hook and the back of the block.

9. For entering buildings, wires with an extra heavy waterproof insulation must be used from the terminal insulators outside to the inside of a building. They must loop down, so that the water may drip off, without entering the building, and the holes through which they enter must slant upward.

10. Service wires must come in contact with nothing save air and their insulating supports, except in unavoidable cases, when a wire with an extra heavy insulation, suitable for the purpose, must be used.

11. The use of porcelain knobs as insulators, except in perfectly dry places or for the support of specially insulated wire, will not be allowed.

12. Soft rubber tubing will not be accepted as a durable waterproof insulation.

13. Wires must enter and leave a building at the same point, and through an approved cut-out switch.

14. The cut-out switch must be "double contact," and should effectually close the main circuit, and cut off the interior, when turned "off." It must be so constructed that there shall be no arc between the points when thrown "on" or "off." It should be automatic in its action in either direction, not stopping between points when once started. It should indicate, upon inspection, whether current be "on" or "off."

15. It must be mounted on a non-conducting base, kept free from moisture, aud be easy of access to firemen and police.

INSIDE WIRES.

16. All wires must be run on walls or ceilings in plain sight, and so as to be open to inspection at any time. They should be kept apart at least 12 inches.

17. In perfectly dry places they may be supported by cleats of wood or porcelain.

18. In wet or damp places a specially insulated waterproof wire must be used, supported by glass or porcelain insulators or hard rubber hooks.

19. When wires pass through walls, floors, partitions, &c., indoors, an extra sheathing of wood or hard rubber should be used. Wires must never be left exposed to disturbance or mechanical injury.

ARC LAMPS.

20. The frames and other exposed parts of arc lamps must be carefully insulated from the circuit.

21. Each lamp must be provided with a proper hand switch, and also with an automatic switch which will shunt the current around the carbons should they fail to feed properly.

22. Stops of some kind must be provided to prevent the carbons from falling out in case their clamps fail to hold them; and these stops must always be in place when the lamp is burning.

23. Lamps must he provided with globes that are closed at the bottom. When placed near combustible material, flyings in fabric factories, or in wood-working establishments, &c., very high globes or spark-arresters surrounded by wire netting must be used. Globes, when broken, must be immediately replaced.

24. Electrical connection between the conducting wires and lamps must be made through a suitable "hanger board" and rods on which the lamp is hung.

INCANDESCENT LAMPS ON ARC LIGHT CIRCUITS.

25. The rules for running wires for arc lamps apply also to incandescent lamps run in series.

26. These must be provided with a proper hand-switch, and also with an automatic switch or other device, which will shunt the circuit around the carbon filament should it break, and thus prevent the maintenance of an arc beyond the terminals of the wires inside the globe.

MULTIPLE SERIES BOXES OR DISTRIBUTORS.

27. Distributors must have the approval of the Exchange before they are put in operation.

28. Wires leading to the distributor, or to supply a series of individual distributors, must be at least 12 inches apart.

29. Wires must be run in plain sight.

30. Wires running from distributor or regulator to the fixtures and lamps, and from mains to individual distributors, must be kept 3 inches apart.

31. The safety fuses must be so proportioned that they will melt long before the wire is heated to an unsafe degree.

32. Dust must not be allowed in the dlstributor box, or on any of the electrical connections.

33. The contact points should be kept clean; solid electrical connections must be secured, and parts kept free to move easily.

34. In case any defect should arise in the distributor or regulator, or the wiring thereto, it must be arranged so as to automatically and absolutely shunt off from the main circuit.

35. Individual distributors must not be hung from the ceiling by a flexible conducting cord or cable, but should be rigidly attached to the ceiling by means of a pipe connection. The distributor must not be less than 6 inches from the ceiling. It should not be hung or placed near any inflammable material. Broken lamps must be replaced at once, or the entire series turned off.

36. Key-sockets, as a rule, must not be used on individual lamps. The pipes or fixtures should be fastened to a wooden block before being fixed to the walls or ceiling.

37. Lamps, distributors, or electroliers must not be attached to any gaspipe or fixture which may be electrically connected with the earth.

DYNAMOS AND MOTORS.

38. Dynamos and motors must be located in a dry place, not exposed to flyings of combustible materials, and must be well insulated upon dry, well varnished wooden foundations. They must be kept thoroughly clean and dry.

39. The wires leading to motors should be separated at least 12 inches from each other, and must be provided with an approved cut-out switch at the point where they enter the building. The same precautions must be observed in entering the building that are required for lighting circuits.

TESTING.

40. All circuits should be tested at least twice a day with a suitable magneto, in order to discover any escapes to ground that may exist. One test should be made in the morning, and another in ample time before starting, to remove any defect, should it be found to exist. The rules for testing should be observed in any separate or isolated plant the same as in central stations.

41. The New England Insurance Exchange reserves the right at any time to add to, change or modify these rules, and to enforce such modifications, changes, &c., as it shall deem necessary for safety; and it will use all reasonable efforts to promptly notify all electric light companies of any change.

42. The signing of these rules by any electric lighting company, or persons controlling electric lights, shall be considered as a guaranty on their part that they will have the testing performed on their circuits or lines as above required.

LEGAL.

Avery v. National Company for the Distribution of Electricity by Secondary Generators, Limited.—(Before Mr. Justice Mathew and a Common Jury)—Tuesday.—This was an action to recover £250, money lent, and for an order compelling the defendant company to register the plaintiff as a holder of 200 preference and 100 ordinary shares, and also for an account of dividends and profits due. The facts of the case were as follow:—The plaintiff is the administrator, and also a creditor of the late George Michael Maurice Yvers Le Fez, a Frenchman resident in London, who was a director of the defendant company, and at the time of his death credited in the books of the company with the sum of £250, money lent to the company, and also appeared on the register as the holder of 200 preference shares and 100 ordinary shares. Le Fez was acquainted with the Count and Countess de Rocquigny, who were then residing in London, and was their debtor. On October 15th, 1884, Le Fez wrote a letter to the directors of the defendant company resigning his directorship and authorising them to transfer the whole of the shares standing in his name into the name of the Countess de Rocquigny, and also assigning the debt for £250 to her. Le Fez committed suicide on October 17th, leaving a will dated October 16th, 1884, which was made according to French law and proved in Paris. After the death of Le Fez, the above letter of October 15th was found in his room, and was taken to the directors on October 23rd by Mr. V. Williams, who was then acting as solicitor for the Countess. The directors refused at first to make the transfer, and the shares and debt were not transferred into the name of the Countess until February, 1885. The case now set up on behalf of the plaintiff was, that the letter of October 15th was not a legal transfer of the shares, and was never delivered by Le Fez to the company, and that the transfer so improperly made should be set aside. Mr. James Pickering, secretary of the company, said that on October 23rd, 1884, Mr. Vaughan Williams brought a letter authorising a transfer of the shares. The Count de Rocquigny brought the certificates in order to have the shares transferred. The shares were transferred when the directors were satisfied that the Countess was entitled to the shares. The Countess received the dividends The chairman and Mr. Gibbs were present when Williams brought the letter. He did not hear how Williams got the letter. The directors at first refused to transfer the shares. Article 28 of the Articles of Association requires a transfer to be signed by both transferor and tranferee. Mr. Vaughan Williams, solicitor for the plaintiff, said the certificates of the shares were handed to a gentleman, who subsequently handed them to him. He was then solicitor for the Countess de Rocquigny. He took the letter of October 15th to the defendant company. He produced to the solicitor of the company an agreement of September, 1883, between Le Fez and Count Rocquigny stating that Le Fez was indebted to

the Count and agreeing to transfer 100 shares to him. He told the directors that the Countess was entitled to the shares as she had supplied the money for them, and Le Fez held them in trust. Cross-examined.—He entered the room where Le Fez shot himself. He found the letter of October 15th, 1884, in the room. The 100 ordinary shares were allotted to Le Fez for services rendered by him. Le Fez claimed all the shares, and it was only when he threatened to give him into custody that Le Fez handed them over. Before the plaintiff consulted him he heard a communication which led him to doubt the Countess's statement. He gave the company notice on May 22nd, 1885, that he was acting for the plaintiff and that they were not to transfer the shares. Counsel having addressed the jury, Mr. Justice Mathew summed up. He said: The question is whether Le Fez at any time before his death acknowledged that he held the shares in question on behalf of the Countess. If he did he constituted himself a trustee for her, and she would be entitled to ask the company to register the shares in her name. It is clear that creditors are entitled to be protected, but clear evidence is required. Where does the evidence come from? The solicitor for the plaintiff is the principal witness, and the defendants had to rely upon his evidence. His own letters show what representations he made at the time. It appears that on October 15th Mr. Williams, instructed by the Countess or her husband, tried to get possession of the certificates for her and demanded them. He got a policeman there to take Le Fez into custody unless he gave them up. What is the explanation of this? By the document of September, 1883, it appears that Le Fez had borrowed money from the Count, and Mr. Williams says that it was because that money was supposed to be the separate estate of the wife that the claim was made. Le Fez had besides on the 15th of October written to the directors authorising them to transfer the shares. You must decide whether or not Le Fez said he was a trustee for her. The jury almost immediately returned a verdict for the defendants.

NOTES.

Electric Lighting and Fires.—The roof of the Gütsch Hotel, in Lucerne, was lately burned down. The earliest news of this event suggested that the fire had been caused by the electric light installation, and especially by the transformer. This supposition was contradicted by circumstances which came out during the inquest held at the scene of the fire. It appeared that the lamps in the hotel, as well as those in other places fed from the transformer in the hotel, were burning as usual half an hour after the outbreak of the fire. This could not have been the case if the fire had been caused by a defect of the transformer. Further, we are informed that the transformer was furnished with fusible cut-outs, so that should any disturbance have occurred in the transformer these fuses would have melted and the lamps gone out. The immediate cause of the fire has not been determined, but it was said that on the afternoon before the outbreak of the fire a plumber had been working in the tower of the hotel. The proprietors of the other hotels in Lucerne, whose lights are also fed from the local central station by means of transformers, were convinced from the first that the cause of the fire was not to be sought for in the transformer. A striking proof that electricity was not believed to be the cause is afforded by the fact that the owner of the central station in Lucerne placed an order for a third dynamo to increase the power of the central station a few days since, and after the fire had taken place.

Central Station Work in Portugal.—The new Central Station of the Companhia de Luez Electrica, Oporto, was inaugurated on the eve of the 31st ult. This company has for some little time past supplied a small number of lamps from five dynamos of various and antiquated patterns, and of English, French, and German origin. The inferior construction of the machinery and general installation was the cause of irregular supply, and the company therefore entrusted Mr. F. Baerlein, of Rua da Prata, Lisbon, with the erection of entirely new plant and buildings. The inauguration took place with the customary festivities, and the general design of building, as well as machinery and plant, earned the highest and deserved praise from all present. The station is designed for an extreme capacity of 3,000 lamps, but only the first section is yet completed, the remainder being added with all possible speed. The installation presents considerable novelty in the general arrangements, most of which have been specially designed by Mr. F. Baerlein, and partly executed in England, partly in Lisbon. We hope shortly to give further details and illustrations of this installation.

Paris Lighting.—The Municipal Council of Paris has determined to adopt a mixed system for the lighting of the town, part to be executed by the Municipal authorities, and part to be carried out by private companies. We had occasion to remark in a previous number that the original stipulations laid down by the authorities were devised apparently with the intention of keeping individuals and companies from competing. The present modification of those prohibitive clauses has, as a matter of fact, in no way ameliorated those conditions.

Picture Gallery Lighting.—The "Künstlerhaus," Vienna, where an exhibition of pictures is being held, is illuminated with 70 arc lights in the interior of the building, and with eight outside. Two Drexler dynamos, each giving 800 ampères and 70 volts are employed, and the current is carried by four naked copper cables.

Electric Lighting in New Zealand.—Mr. J. C. Firth has submitted plans for the lighting of the City of Auckland by means of eight towers. Each tower will light a circle of over 50 chains in diameter, and will have on it four arc lights of 2,000 candle-power each, but two additional lamps can be added if necessary, making a 12,000 candle-power light for each tower. These towers will vary in height from 100 to 125 feet. The present lighting of the city is about 5,000 candle-power; the electric light system proposed would give 64,000 candle-power. There will be 12 times the illuminating power, at only an increase of 10 per cent. in cost.

The Council of Christchurch, New Zealand, invites tenders for lighting the city by electricity, in accordance with the specification and conditions to be seen at the office of the Agent-General for New Zealand, 7, Westminster Chambers, Victoria Street, London. Tenders to be sent direct to the Christchurch City Council, New Zealand, to arrive by the 1st July.

Dublin and the Electric Light.—The Corporation of the City of Dublin is applying under the Electric Lighting Act to the Board of Trade for authority to supply the city with electric light. It asks for liberty for this purpose "to open and break up streets and bridges, to alter the position of gas and water mains, pipes and wires, sewers and drains, under the same; to acquire lands, to appropriate lands, to construct such works, acquire such licences, to enter into such contract, and to do all such acts and things as may be necessary and incidental to such supply." The proposed area of supply is the city without limitation of any district. Whoever desires to make any objection to the project must do so by letter to the Board of Trade within two months. Reference was made to the subject of lighting by the Lord Mayor in the speech on practical topics which he delivered at the High Sheriff's dinner. The allusion was direct enough. "Will you say, Mr. High Sheriff (said his lordship), that the condition of the public lighting of the city of Dublin is in a condition in which it ought to remain? I appeal to the High Sheriff with confidence, because I am aware that no personal relation in which he stands can affect either the keenness of his intellect or in public affairs the impartiality of his judgment. I say that neither in regard to cost, nor the character nor the control, is the system of public lighting in Dublin satisfactory." Thus appealed to, the High Sheriff stated that, though a director of the Gas Company, he believed that the supplying of light to the city should be under municipal control.

Electric Light and House Decoration.—Mr. Withycombe, the landlord of the Castle Hotel, Taunton, fitted up the hotel with the electric light when it was first introduced into the town about two years ago. Mr. Withycombe finds that the annual re-painting and decorating which were formerly necessary are not now needed, and the lapse of two years since the electric light was introduced, during which no painting or decorating has been done, leaves all the details of distemper and gilding less injured than they would have been after a few weeks of gas lighting.

Mansion Lighting.—Messrs. B. Verity and Sons have just completed the lighting of Ascot House, the residence of Mr. Leopold de Rothschild, and are now engaged upon the neighbouring mansion of Lord Rosebery, Mentmore. They have also numerous other installations in hand.

Leamington and the Electric Light.—At a meeting of the Leamington Town Council on Monday afternoon, the Finance Committee reported claims against the town amounting to £2,638 16s. 10d., which having been examined were recommended for payment. Amongst the items was one of £96 5s. for the supply of the electric light from January 7th to March 31st. In reply to questions, the Clerk said the item was one which the Council had contracted to pay to the Electric Lighting Company for supplying the electric light to the Parade. There was a total yearly sum to be paid to the company, and this item was one-fourth of that sum. The sum now paid for the electric light was about double what had been paid for gas for the same portion of the town; but it should be remembered that there were twice the number of lights. Mr. Crowther Davies desired to know whether it was a fact that they had to pay nearly £400 per annum for the electric light supplied to the Parade, because if that were so it appeared to him that they were paying very dear for their "electric light whistle." The Mayor explained that this item was part of a contract which had been entered into. In reply to Mr. White, the Clerk said he considered that the actual contract between the Council and the Electric Lighting Company did not come into operation on the 1st of January last, but about the second week of February. But the surveyor, who was thoroughly well informed in the matter, considered that as the town had a considerable quantity of the electric light supplied in the month of November and December, for which no charge was made, that it would be fair to allow the charge to commence on the 1st of January. The Council would also bear in mind that there had been a considerable reduction in the gas bill. Mr. Crowther Davies asked what had been the cost of the gas. The Clerk said it had been about half the amount they were paying for the electric light, but they had double the quantity of light. Mr. Burgess wished to know if the charge for the electric light would be the same from March to June, and from June to September, as from September to December and from January to March? The Mayor replied that the present charge was precisely one-fourth of the yearly sum to be paid, and the item would be the same in each quarter. The report was then adopted.

Bognor and the Electric Light.—At the last meeting of the Bognor Town Council, Mr. Smith, in moving the adoption of the Finance Committee's report, said the committee had hitherto provided for the lighting of the town with gas; but there had been considerable discussion in committee as to whether it would not be possible to have the town lighted with the electric light. He was not quite sure that, taking into consideration the considerable price they paid for gas compared with other towns, the cost of electric light would be very great, but he purposed to enlighten the board on that point at a future meeting.

Theatre Lighting.—Incandescent lamps are now largely employed in the Alhambra Theatre, which has just been redecorated.

Lighting the House of Commons.—Shorter sittings in the House of Commons will mean a decrease in the portentous bill for lighting our legislative buildings. For gas, last year, the nation paid the sum of £3,300; for electricity, £480; and for oil, used only in the committee-rooms, lobbies, and the residences of the officers of the House, £2,000.

Weston-super-Mare and the Electric Light.—Weston has not yet given up the idea of adopting the electric light. The *Gazette* last week said:—"The question of the electric light forces itself on public attention. People are far from satisfied that nothing is likely to be done for the coming season. Other places are on the move. Exeter got the plant we had here last year, and it is not inclined to part with it until it has secured a larger and more complete installation. Cheltenham has now taken up the question, and a special committee, appointed by the Town Council, has paid a visit to Taunton, to examine for themselves the installation there carried out by the local electric lighting company, and they were delighted with what they saw. It is now proposed by the Taunton Corporation, acting upon an influential requisition that the lighting may be extended, to accept the offer made by the lighting company, viz., to cancel the former contract, and to increase the number of arc lamps from 30 to 60, at a charge of £18 10s. each per annum. Other places are going forward. Will the new board at Weston reconsider the matter, and decide on some definite policy?"

Electrical Communication in the Houses of Parliament.—In the discussion of the Civil Service estimates last week, reference was made to the need for better means of communication between different parts of the House, and Mr. Plunket, First Commissioner of Works, said he had arranged that certain information should be given at the library and smoke rooms, and other places, as to what was going on in the House.

Telephone in Peru.—The Peruvian Government has published the conditions under which tenders will be received for the establishing of the telephone service in the Republic. The adjudication will take place in four months, dating from the 26th January, 1888. A monopoly of 15 years will be granted, but the Government reserves the right of suspending the service for a period of three months should political exigencies demand such a proceeding.

An Undeveloped Treasure.—The *Financial News* speaks of the United Telephone Company as an undeveloped treasure, and says the directors control a splendid property which has become great almost in spite of them, but which is as yet far from what it may easily be made. Comparisons are given between London, on the one hand, and Liverpool and Manchester, and Glasgow on the other. From these it seems that the subscription per head of population in the Metropolitan area is but 4½d., whilst in the Liverpool and Manchester district it is 11½d. and in Glasgow 7¾d. Our contemporary says that if the figures were reversed, and London showed a subscription of 11½d. per head and Glasgow 4½d., there would still be very little credit for London, which should be the greatest telephone centre of the world. The two extra strings to the bow, royalties and profits from subsidiary companies, have enabled the United Telephone Company to pay large dividends at the same that it has allowed its own system to remain but slightly developed. The present value of the United Company's entire holding in subsidiary companies is not much under half a million sterling, and this half million promises to go on growing at the rate of £40,000 to £50,000 a year. The late Mr. Abbott two years ago proposed that the shares in the company's treasury should be transferred to a special trust; and had he lived he would have repeated that proposal this year. The income of the London area, says the *Financial News*, and we quite agree, might with

proper energy have been double what it is, and there is still £30,000 or £40,000 yearly net of undeveloped business in it. The royalties must now be worth something like £45,000 to £50,000 a year, and as they have three years to run (excluding the possible contingency of their extension), represent a cash value of £150,000. Estimating the company's Metropolitan rights at £1,000,000, its provincial shares at £500,000, and its royalties at £200,000, there is actual money value in sight for £16 10s. per share. United Telephone Company's shares at their present price, say 15, which includes the surplus dividend of the year, though they appear to carry a premium of nearly 300 per cent., are in fact considerably below the cash value of the assets they cover. The element of future appreciation is entirely ignored in them.

Telephonic Communication in the North of Ireland.—The National Telephone Company is putting forth every effort, where they receive the slightest encouragement, to connect the adjacent towns of the North of Ireland to Belfast. A special line has just been laid to Larne. Previously there was a wire to Carrickfergus, but now there is a separate line extending right through from Belfast to the thriving seaport mentioned.

Telegraph to China.—The Great Northern Telegraph Company announces that stations have been opened on the Island of Formosa, at Taiwan, Takow and Anping. The rate from all places in the United Kingdom is 8s. 9d. per word.

The Lewis Cable.—Dr. M'Donald asked the Postmaster-General in the House of Commons on Tuesday when it was his intention to have the telegraph cable between Lewis and the mainland, which had been out of order for several weeks, repaired; and whether, having regard to the large fishing interests of the island, which were mainly dependent for the sale of fish on telegraphic intelligence, he intended to lay a new cable instead of that now out of order. Mr. Raikes replied that the cable ship belonging to the Post Office, was at that moment engaged in the repair of the Stornoway cable.

Antilles Cables.—We learn that two sections of this system are completed and are in working order, viz; La Guayra-Curacao and Curaçao-Santo Domingo. The ss. *Roddam* is now engaged in laying the St. Nicolas-Puerto Plata section, upon the completion of which the last portion of the system, the St. Nicolas-Santiago de Cuba section will be laid. M. Jean Frayssinier has been appointed general manager of the cables, with head quarters at Santiago de Cuba.

Fire at Bournemouth.—We are sorry to hear that the fire which recently broke out in Trinity Chambers, Bournemouth, played sad havoc with the testing instruments and medical appliances of Mr. W. Lynd, editor of the *Telegraphist*. Mr. Lynd was uninsured, and the loss of his instruments has been a heavy blow to him.

Domestic Electrical Supplies.—Under this title the Woodhouse and Rawson Electric Supply Company has just issued a second edition of a portion of its catalogue forming an ironmongers' list, to be followed by a reproduction of the remainder to form a contractors' list. The domestic electric supplies portion contains new matter relating to electric gas lighting burners and the "Standard" series of small accumulators, which are recommended for a great variety of purposes. Seven pages are devoted to a description of the Swinton telephone, unfortunately cancelled with a notice that owing to the injunction obtained by the United Company, these instruments cannot be supplied at present. The "English" telephone, however, is not only described, but offered for sale, with a full guarantee. Altogether, the list is a great improvement upon the former edition, and forms a valuable book of reference to all interested in this department of business.

Transformers v. Accumulators.—The paper of Mr. R. E. Crompton, upon Transformers *v.* Accumulators for Central Station Lighting, which was announced to be read last night before the Society of Telegraph-Engineers and Electricians, will probably be considered one of the most valuable, in its practical bearing, of any in the Society's proceedings. From a series of load diagrams prepared both here and in America, Mr. Crompton finds that a central station equal to supplying 600 kilowatts (10,000 lamps of 16 candle-power each, simultaneously alight), could only calculate upon disposing of an average quantity of 2,100 units per day. Mr. Crompton compares the two systems from four standpoints: trustworthiness, steadiness, and quality of the lighting; first cost of plant; working cost and maintenance; and lastly, as to the probable output, and hence maximum income, that can be safely obtained from the sale of electricity in each case. Upon these four points the author thinks it will be conceded that the commercial success of electric light undertakings rests. For the data contained in his paper Mr. Crompton makes the comparison for a system of supply for London, for 10,000 60-watt lamps, or their equivalent, simultaneously alight at hours of maximum demand; 1st, by alternating currents reduced from 2,000 volts to 60 volts by transformers; and 2ndly, by direct currents reduced from 440 volts to 110 volts by accumulators used as transformers. The cost of each station is estimated to be nearly the same, *viz.*, £57,440 for the transformer plant, and £59,762 for the other. The working expenses for the beforementioned 2,100 units per day are figured out at 3·75d. per unit for transformers and 2·7d. for accumulators. Doubtless a very lively discussion ensued between the advocates of both systems, but Mr. Crompton being a man who bases his remarks on hard facts instead of assumptions will be hard to beat, and his contention that it is more economical in almost every respect to use accumulators must have great influence upon the future of electric light central stations in this country. The reason why the transformer system is the more costly of the two is due, says Mr. Crompton, to the fact that the main cause of expense is the heavy cost of material, labour, and superintendence during the long hours in which the continually moving machinery is working very lightly loaded. We shall probably have much more to say upon this subject in our next issue, in which we hope will appear both the paper itself and the discussion thereon.

Electrical Welding.—Prof. A. E. Dolbear writes to the *American Engineering Record* as follows:—"I have had made nearly a hundred tests of the tensile strength of electrically-welded bars of iron, steel, and other metals. The results were of such a character that I can state positively that with Thomson's welding process it is possible to weld both wrought iron and steel so that the weld is as strong as the same cross-section in another part of the bar. I had a number of bars welded by an expert blacksmith and a number of similar ones by the electrical process for comparison, with the result that the electrically-welded bars were much stronger than those welded by the ordinary process. The bars were of various sizes, up to an inch and a half for iron, and three-fourths of an inch octagon steel."

Communication with Lightships.—A deputation from the Associated Chambers of Commerce waited upon Sir M. Hicks-Beach yesterday in reference to the subject of harbours of refuge, communication with lightships, &c. Replying upon the latter, Sir Michael referred to the *Sunk* experiments, and said they had not been sufficiently long on trial for a definite opinion to be formed.

Removal.—Messrs. W. F. Dennis & Co. have removed from 101, Leadenhall Street, to No. 11, Billiter Street, E.C.

The Electro-Harmonic Society.—The last smoking concert of the season took place on Friday last in the presence of a large and representative gathering of members and friends. The programme, which consisted mainly of classical items, appeared to create great interest, and a general impression seemed to prevail that on this occasion all previous efforts to meet the requirements of the audience had been eclipsed. The remarks of the chairman, Mr. Graves, who very courteously expressed his willingness to preside, were received with acclamation, especially when he alluded to the success of the meetings generally, and it is now beyond the shadow of a doubt that electricians of every degree have found in these concerts a most enjoyable means of passing away a few hours in congenial companionship and free from the trammels of business; in fact, a void which had hitherto existed in the social life of our professional friends has been filled with a measure of success which we believe was scarcely anticipated by the promoters of the movement. We may safely say that there will be wanting no effort on the part of those who are responsible for the conduct of the Society towards making the third season even more successful, and gentlemen desirous of becoming candidates for membership should lose no time in making application to the Hon. Sec., Mr. H. Alabaster, Brockenhurst, Therapia Road, Honor Oak, London, S.E.

The Cable ss. "International."—This vessel, owned by the Silvertown company, arrived in the river on April 11th from Massowah, where she has been engaged under charter to the Italian Government for supplying the troops with condensed water.

Interruptions and Repairs to Cables and Land Lines.—From the *Journal Télégraphique* of Berne:—

	Interrupted.	Repaired.
Cable. — Constantinople-Odessa ...	29 Feb., 1888	Still interrupted.
Land Line.—Saigon-Bangkok	20 Jan. „	2 March, 1888.
„ —Saigon-Bangkok	7 March „	8 „ „
„ — Moulmein-Bangkok ...	4 „ „	6 „ „
Cable.—Suez-Souakim ...	6 „ „	Still interrupted.*
„ —St. Vincent - Barbadoes	13 Feb. „	8 March, 1888.
Land Line.—Halfa-Korosko (Up. Egypt)...	6 March „	9 „ „
Cable.—Souakim-Perim ...	6 „ „	20 „ „

Sale of Buildings.—The important sale of buildings which formed the Liverpool Jubilee Exhibition will be held on April 17th and three following days, illustrated catalogues being now ready. The erections are said to be of a massive and substantial character well worth the notice of promoters of exhibitions, proprietors of places of public resort, and of iron, shipbuilding, and other works. In addition to the buildings, the catalogue also includes a large number of chairs, garden seats, and other effects.

Voltaic Electricity.—"Voltaic Electricity," by T. P. Treglohan, is a text-book on electricity which we have not had the opportunity of perusing, but if the criticism which appeared in *Nature* upon this work is in any way well deserved, we can confidently say that we don't want to peruse it.

Transmission of Power.—The *Gold Field Times*, of Barberton, Transvaal, contains an article descriptive of the electrical transmission of power, and advocates its application to mining industries. The statement is made that on the Sheba range, where wood is the fuel used, the present cost of working two or three batteries, not including labour, amounts to £150 per H.P. per annum; whereas, we are told, that power could be electrically transmitted from a distance of 5 miles at a cost, labour included, of under £50 per H.P. per annum.

* A *Times* telegram from Suakim last week announced that the Suez cable had been repaired, and that both lines were working.

Paris Exhibition of 1889.—The following gentlemen have been selected as the syndicate for the electric lighting of the Paris Exhibition of 1889. As director, M. de Bovet, mining engineer; as chief engineer, M. Picore, chief of the Edison Continental Company's works; and as inspectors, MM. Napoli and Dumont, engineers of the Chemins de fer de L'Est Company.

Personal.—Mr. Bailey, of Fulham Pottery, has retired from the electrical business recently conducted in his name at 168, Upper Thames Street, being succeeded by Messrs. Tyndale, Gibbons and Company.

Electric Traction at Brussels.—The annual report of the Administrative Council of the Brussels Tramway Company states that the working of three cars electrically during 1887 has resulted in a loss of £635. The service was commenced on April 17th, 1885, with one car running between the Place Royale and the Rue Belliard. A second car was run on May 8th, and a third on September 19th. These cars are at present running in the Rue de la Loi. The electric cars covered last year 34,500 miles. The financial failure, although not officially so stated, is due to the rapid wearing out of the accumulators. The depreciation of these is calculated at 22 centimes per kilometre—or say 3½d. per car mile; and as this estimate does not allow for general charges, nor for the cost of power, it is evident that the total working expenses must be considerable. The destruction of the plates is ascribed to the continual surging of the acid among them, coupled with the vibration to which the cells are exposed. M. Julien proposes to remedy the defect by placing a number of rubber rings round the plates, the rubbers to act as separators, and at the same time to sub-divide the acid into smaller quantities, and so limit the surging action.

The Magnetic Circuit of Dynamo Machines.—Mr. Henry W. Ravenshaw, writing to *Industries* upon this subject, says:—Profs. Ayrton and Perry have pointed out at the Physical Society that it is practically impossible to calculate the characteristic of a continuous current dynamo from the drawings. I am glad to be able to point out to them that the means of calculating the characteristic can be obtained from the papers on the subject by Mr. Kapp, and from the reports of the discussions on them. I may say that I have lately designed a complete series of dynamos of a new type, and have never had a preliminary test, and though numbers have been made with considerable modifications in the design, the volts at the calculated speed have always been within 2 per cent. of the mean. In many cases the dynamos have not been tested at the factory, but have been fitted on to the bed plate by the engine maker, the allowance made for the effect of the proximity of the engine and flywheel being found correct. This has been done, not in a lecture room or study, but as part of the duties of a factory manager; and I need hardly point out that the saving of time and expense in being able to build machines without preliminary tests or alterations is immense. The methods I use are simply those given by Mr. Kapp, with the exception of the loss from leakage, in which case I use Prof. Forbes's lemmas.

Dynamo Armatures.—Messrs. F. H. Royce & Co. write that they built a dynamo machine as far back as 1886 which had its armature wound in the manner described in the patent specification of Messrs. Paris and Scott, No. 5,462 of 1887, an abstract of which appears on page 350 of the REVIEW for March 30th.

Lightning in Belgium.—In the *Journal Telegraphique* statistics of persons and animals struck by lightning in Belgium during 1886 are given. We learn that 28 persons were injured and four persons and 33 animals were killed. The most curious case was that in which a school boy walking between two men was only knocked down and slightly burned, while the two men were killed. The boy was carrying an open umbrella at the time.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Woodhouse and Rawson, Limited.—At an extraordinary meeting of the shareholders of this company, held at 11, Queen Victoria Street, on the 14th ult., special resolutions were passed authorising certain alterations in the articles of association. The principal of these is a provision that no one call shall exceed 25 per cent. of the nominal amount of the shares, and that such calls shall be made at intervals of not less than two months. The resolutions were confirmed on the 29th ult., and were duly registered on the 6th inst.

An agreement of 29th ult. (filed 3rd inst.) provides for the granting to the company of a new lease of the manufactories and buildings at the rear of the West Kensington Hall, Hammersmith Road, under which reduced rents are payable. As consideration the company will grant the lessors, Messrs. W. C. Cozalet and F. Pennington, 380 fully-paid shares.

Orient Electric Light Company.—The registered office of this company is now situate at 2, East India Avenue, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

The Telephone Company of Ireland, Limited.

THE ninth ordinary general meeting of the proprietors of this company was held at the offices, Commercial Buildings, Dublin, on Monday.

Mr. V. B. Dillon, solicitor to the company, was in attendance.

Mr. Joseph Bond Morgan, in moving that the High Sheriff, Alderman Winstanley, should take the chair, said they regretted exceedingly that they had not amongst them their late chairman, Mr. Edmund Dwyer Gray. The Telephone Company would miss him immensely, for he was a great power not only in that company but also in respect of the assistance which, as a member of Parliament, he rendered to telephone interests generally. He took a very active part in a special committee ordered by Parliament to consider the position of the telephone companies in relation to a bill in which they sought to obtain the power of wayleaves. His action in the matter had been of great service to telephone interests, and the matter was now being pressed with great vigour, and they trusted that material benefits would result to the companies.

Mr. Hermann G. Erichsen, in seconding the motion, said he would only repeat what had been said in the public prints of Mr. Gray, namely, that he was a most honest, honourable, amiable, and, he would add, able man.

Alderman Winstanley, having taken the chair, moved the adoption of the report, which has been already published, and the accounts. He said he could not do so without alluding to the great loss which that and other telephone companies had sustained by the death of their late lamented chairman. He was a man the like of whom they seldom met. Not only was he an excellent man of business, but he was a man well known throughout the whole of the United Kingdom. In his business capacity, as a literary man, and as an orator, he adorned everything that he touched, and brought to whatever he undertook an amount of intelligence, perseverance, and industry that guaranteed success. They had always found him an excellent member of the board of that company, for whenever they found themselves in a difficulty they had only to refer to him in order to be assisted through, and enabled to carry whatever they had in hand to a successful issue. Much had been said of him in the public Press of England, Ireland, and Scotland, but not a word more than he deserved. With regard to the report, the figures which it contained spoke for themselves, and showed that the company had been fairly successful during the year. They obtained 73 new subscribers during the year, but lost 52 by deaths and other causes, which left a net increase of 21. During the first couple of years they did not write off any bad debts. In fact they thought their business would not lead to any, but they found it impossible to avoid them. From deaths, failures, and one cause or another, they made something over £100 a year of bad debts, and these accumulated to £323 7s. 6d.; but in the year 1887 they had not only written off the whole of that amount, so as to be able to start fair in 1888, but they had also been able to put 10 per cent. of their earnings to their reserve fund and to carry a considerable sum forward. They had also made such arrangements as would, he believed, enable them to avoid bad debts in future, or at all events to incur very few. Arrears were no longer allowed to accumulate in the Post Office royalty, which was payable in advance. Their business was now on a sounder basis than it had been in any previous year, and all doubtful proposals were declined, except on such terms as would insure the company against loss. It was a matter of congratulation to the shareholders that the gross revenue of the Dublin exchange for the past year had been upwards of £10,000. In the year 1884 it was under £5,000, so that in three years it had increased at the rate of 400 per cent. That was a satisfactory and remarkable development, and it would be more pronounced but for the obstruction which they still received from the Postal Telegraph Department. The directors would have long since established call offices at all the suburban railway stations, and at the suburban post offices where no telegraph existed, but for the refusal of the Post Office to give their consent—a policy which he considered wholly inexplicable. It was to be hoped, however, that the Postmaster-General would soon give them a fair field, and that the heavy tax of 10 per cent. on their gross revenue would be removed, and every possible facility given for their operations, for it was a scandal that what had become a necessity for all business pursuits should be subject to the existing tax upon it. It was also very hard that the Government should arbitrarily refuse the company leave to have call offices at the railway stations merely because the former claimed exclusive rights for telegraphic purposes. In addition, if the telephone company wanted to cross a railway or to go along its banks they were charged an extra tax besides the 10 per cent. royalty on their gross income in consequence of this claim of the Government to the exclusive use of the railways for telegraphic purposes. In this connection the company would greatly miss the energy and ability of their late chairman, who was deeply interested in the removal of the obstructions placed in the way of the development of the telephone system, in which he took an absorbing interest, and who had done great service not only to that company, but to the telephone world in general by his action in Parliament and the interviews which he had with the Postmaster-General on various occasions.

Mr. Erichsen seconded the motion, which was unanimously agreed to.

The Chairman moved a resolution for the payment of a dividend at the rate of 1 per cent. per annum on the ordinary share capital of the company, and confirming an ad interim dividend of ¾ per cent. per annum paid last August.

Mr. Erichsen seconded the motion, which passed unanimously.

The proceedings then terminated.

The Oriental Telephone Company, Limited.

THE report of the directors for the year ending 31st December, 1887, states that the revenue account for the year exhibits a balance to credit of £5,854 15s. 10d., which has been transferred to the profit and loss account. To this amount has to be added the sum of £4,769 11s. 3d. brought forward from last year, making a total sum to credit of profit and loss of £10,624 7s. 1d. In accordance with previous balance sheets, the Indian guarantees for the year, viz.:—£2,406 18s. 11d. have been debited to this account.

The directors have deemed it advisable to reduce the item of preliminary expenses, and have consequently written off a sum of £1,128 in respect of these. They have further written off £259 7s. 10d. for depreciation of stores at the various branches and £121 3s. 3d. in final settlement of losses on shipments of instruments to Australia on joint account dating from 1882 with the Consolidated Telephone Construction and Maintenance Company, Limited. The net balance, therefore, to credit of profit and loss, after deducting the above items, is £6,708 17s. 1d.

The directors recommend a dividend for the past year of 2½ per cent., free of income tax, on the paid-up capital of the company other than the vendors' shares. This dividend will absorb £3,106 1s., and leave £3,602 16s. 1d. to be carried forward.

The Telephone Company of Egypt continues to make satisfactory progress and the dividend of 6 per cent. declared by that company for the past year on its preferred capital has been brought into the present accounts.

The revenues of the Indian subsidiary companies are maintained. The deferred shares held by this company will this year rank for dividend as well as the preferred shares.

The China and Japan Company has, as was anticipated in last year's report, been able to finally extinguish the deficit arising on previous years' workings, pay its debenture interest and carry a small sum forward.

The exchanges worked by the company all show a profit for the year. In order to give the most efficient service at Rangoon, the magneto system is now being introduced. This completes the change of system throughout the Indian exchanges.

Electrical Power Storage Company, Limited.—The gross profit for the year is £11,875 1s. The directors have made provision for depreciation of plant, machinery, buildings, and doubtful debts, by writing off the sum of £1,569 1s. 7d; £1,000 have also been written off from the patent account. After deducting the expenditure of the year and the amount of depreciation, &c., a balance remains to the credit of the account of £10,793 6s. 11d., out of which the directors propose to place £4,000 to the credit of a reserve fund, leaving a balance of £6,793 6s. 11d. to be carried forward.

Indo-European Telegraph Company, Limited.—The directors, after adding £10,000 to the reserve fund, have determined, subject to audit, to recommend the payment of a dividend for the six months ended December 31st, 1887, of 17s. 6d. per share, making with the interim dividend already paid 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year, carrying over £2,694 15s. 1d. The dividend and bonus will be payable on and after May 1st next

Western and Brazilian Telegraph Company, Limited.—The directors, after placing £15,000 to renewal fund and £10,000 to debenture redemption fund, have decided to recommend at the forthcoming meeting of the company that a dividend of 9s. per share, free of income tax, be paid. This dividend, with the interim one already paid in October last, makes a total distribution for the past year of 4½ per cent. per annum, as compared with 3½ for the year 1886.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 6th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,554.

The Great Northern Telegraph Company, Limited. The receipts for March, 1888, £22,000; January 1st to 31st March, 1888, £63,800; corresponding months, 1887, £61,200; and of 1886, £58,680.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of March, 1888, amounted to £39,670, against £38,177 in the corresponding period of 1887—an increase of £1,493.

The Eastern Telegraph Company, Limited. The receipts for March, 1888, amounted to £54,376, against £49,797 in the corresponding month last year.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending April 6th amounted to £4,350.

NEW PATENTS—1888.

4453. "Improvements in railway signalling, which he names 'Shakeshaft's automatic electric railway signal.'" J. SHAKESHAFT. Dated March 23.

4456. "An improved method of administering galvanic currents for curative purposes." A. COLLINGRIDGE. Dated March 23.

4474. "Improvements in structures for supporting electric and other conduits, and for facilitating access to buildings." B. DUKES. (Communicated by M. J. Hart, United States.) Dated March 23.

4485. "Improvements in extracting gold and silver from refractory and all other ores by electro-chemical chlorination, and also in recovering the whole of the chlorine by the same process." F. MADDICK and J. GREENWOOD. Dated March 23.

4489. "An improvement in holders for electrical glow lamps." E. F. H. H. LAUCKERT and E. H. HAENSEL. Dated March 23.

4523. "Telegraphic and telephonic apparatus, part being applicable to other electrical purposes." J. KELMAN. Dated March 24.

4524. "Improvements in portable galvanic batteries." W. J. S. BARBER-STARKEY. Dated March 24.

4559. "Improvements in electric arc lamps." F. DE WOLFFERS. Dated March 24.

4561. "An improved battery jar." C. A. BROWN. Dated March 24. (*Complete.*)

4568. "Improvements in or relating to conductors for electrical and acoustic purposes." S. WILLIAMS. Dated March 26.

4579. "A new or improved electrical apparatus for combining an electrical alarum with the ordinary mechanical alarum." J. J. DILLON. Dated March 26.

4593. "Improvements in electrical batteries and methods of closing the same." F. L. RAWSON and W. WHITE. Dated March 26.

4604. "Improvements in automatic apparatus for the continuous opening and closing of electric circuits." L. S. M. PYKE and H. T. BARNETT. Dated March 26.

4626. "Improvements in the electrolytic production of metals." C. HOEPFNER. Dated March 26.

4627. "An improved method of using incandescent electric lights." C. WELLS and F. J. GOAD. Dated March 26.

4673. "Improvements in and connected with apparatus for the generation and utilisation of electric currents." P. M. JUSTICE. (Communicated by C. Heisler, United States.) Dated March 27. (*Complete.*)

4730. "An electro-magnetic time-piece." G. VENABLES. Dated March 28.

4759. "Improvements in and relating to telephonic apparatus." H. H. LAKE. (Communicated by International Dudley Signal Company, United States.) Dated March 28.

4764. "Improvements in portable galvanic and electro-magnetic batteries for medical purposes." A. L. FRY. Dated March 28.

4804. "A new switching arrangement for electric signalling, telephones, telegraphs, &c., by means of which any number of instruments may be worked on one single line, one with the other." E. J. PIPER. Dated March 29.

4819. "Battery for general electro-medical use, or as electrical dumbbells, Indian clubs, and the like, for muscular exercise with electrical current of any desired strength during such exercise." W. G. JOHNSON. Dated March 29.

4844. "Improvements in or relating to holders for incandescent electric lamps by which they are made applicable as combined holders and circuit closers and breakers." W. P. THOMPSON. (Communicated by N. E. Garczynski.) Dated March 31.

4875. "Improvements in machinery for raising and lowering submarine telegraph or other cables." A. WILSON and J. F. TAFE. Dated March 31.

4909. "An improved telephonic apparatus." J. C. FELL. (Communicated by P. C. C. Otzen, Denmark.) Dated March 31.

4929. "Improvements in magneto-electric generators. W. GILLETT and G. HASELTINE. Dated April 3. (*Complete.*)

4940. "Improvements in and relating to alternating current dynamo-electric machines. T. PARKER. Dated April 3.

4945. "Improvements in the method of coupling together alternate current electric machines." C. F. PROCTOR. Dated April 3.

4964. "Improvements in apparatus for the changing and regulating of electric currents." A. J. BOULT. (Communicated by S. Doubrava, Austria.) Dated April 3. (*Complete.*)

5029. "Generation of electricity by tidal or river power." A. H. MOBSBY and A. F. DAVIES. Dated April 4.

5069. "A combined mechanical and electro-magnetic motor." C. A. RANDALL. Dated April 5.

5082. "Electricity meters." R. P. SELLON and R. C. JACKSON. Dated Aprid 5.

5098. "Method of and apparatus for electrical signalling or announcing in connection with telephone circuits." P. L. KRICBOOM. Dated April 5.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

266. "Improvements in electric telegraphs." E. EDWARDS. (Communicated from abroad by D. Kunhardt, of Germany.) Dated January 7. 1s. 8d. Claims:—1. An electric quick telegraph, provided with any desired number of rotating cones for transmitting the corresponding number of telegraphic messages to different stations at the same time, substantially as described and shown. 2. In the said electric quick telegraph the arrangement of contacts formed by points and dashes combined, corresponding to the signs of the Morse system, and fitted on the rotating cones, substantially as described and shown. 3. The arrangement of keys, one being provided to each type, substantially as described and shown. 4. The arrangement of pawls or detents for the purpose of keeping the keys pressed down until the type has passed, substantially as described and shown. 5. The arrangement of projections upon the cones releasing the said pawls or detents as soon as the type has passed, so that the key may rise, substantially as described and shown. 6. The arrangement of the contacts in such manner as to close by the commutator the circuits of the different receiving apparatus, so that the first current from the transmitting station will be influenced and operate the first receiving apparatus of the receiving station, and will then further put the other receiving apparatus in position to operate by closing the third reversed current from the transmitting station and so on successively, substantially as described and shown in the drawings.

700. "Improvements in electric furnaces and apparatus for heating, lighting, and carrying on chemical processes, and in the working of such furnaces or apparatus." S. Z. DE FERRANTI. Dated January 15. 8d. Claims:—1. An electric furnace or apparatus in which metal or material whilst contained in a suitable crucible or vessel is heated or melted by currents induced directly in it. 2. An electric furnace or apparatus composed of a crucible or containing vessel heated by induced currents circulating in it, or in the material contained in it, without such currents being conducted there from the outside. 3. An electric furnace or apparatus composed of an annular crucible or vessel of refractory material in a varying or alternating magnetic field, or in a rotating or moving field. 4. An electric furnace or apparatus composed of an annular crucible or vessel of conducting metal or material in a varying or alternating magnetic field, or in a rotating or moving field. 5. The construction of electric furnaces or apparatus, substantially in the manner described and illustrated in the drawings.

1741. "Improvements in apparatus for making and breaking electrical circuits." S. SUDWORTH. and C. K. FALKENSTEIN. Dated February 3. 8d. Relates to improvements in apparatus for making and breaking electrical circuits, and has for its object the ensuring of a simultaneous breaking of the circuit at a number of distant points so as to insure a minimum of sparking, and consequent reduction of wear and tear of the working parts. In its general arrangement, the apparatus consists of a suitably formed base of insulating material on which, in the case of a two pole switch, the four electrically separate contact pieces are rigidly mounted. These contact pieces are so disposed and placed in pairs on the base as to admit of the passage between each pair of them, of a lever or other suitable device by which the circuit between the two is completed or broken as required. When in their normal position the levers are out of contact with the pairs of contact pieces and the circuit is broken in two places. The levers are constructed from any suitable insulating material, and have at or near their ends metallic pieces which when forced into or between the pairs of contact pieces completes the circuit between them. The claims are 2 in number.

3560. "Improvements in holders and fittings for electric lamps." E. C. WARBURTON. Dated March 9. 8d. The invention has a tubular or cylindrical box open at the lower end, and made, say, in two pieces—viz., the body or main portion, which is open at the lower end and is closed at the upper end by a cover attached to the body, preferably by means of a bayonet joint and thumb screws. On an annular ledge in the box is fitted a disc of wood, ebonite, or other suitable insulating material, which is secured in position by pins or otherwise, and has two holes drilled vertically through it. These holes are for the reception of two closely coiled spiral or helical springs of conical form, the upper and wider ends of which are soldered or otherwise secured into holes countersunk in two plates or terminals, secured by screws to the upper side of the wooden disc. Through the hole in each plate and down the centre of each conical spiral spring is passed a pin, which has a head at its upper end and terminates in a hook at the other and lower extremity, near which it is soldered to the apex of the conical spring through which it is passed. This arrangement admits of a longitudinal or vertical in addition to a latitudinal or horizontal movement being imparted to the hooks at the lower ends of the pins by simply pressing or operating the heads at the upper ends. To attach the lamp bulb to the holder, therefore, it is only necessary to insert the end of the bulb into the open end of the holder, and then operate the heads of the pins so as to bring the hooks into the required positions to connect them to the platinum or other eyelets or loops on the lamp bulb. The claims are 5 in number.

6853. "Improvements in metal-cased electric lines or cables." R. W. EDDISON. Dated May 10. 8d. Claims:—1. The combination of the terminal of an insulated electrical conductor with a metal sheathing, having its end disconnected from its main part, and a moisture-resisting and insulating substance interposed between the said disconnected end and main part of the sheathing, substantially as set forth. 2. The combination of the terminal of an insulated electrical conductor with a metal sheathing, having its end disconnected from its main part and a rubber sleeve connecting the two parts of the sheathing, substantially as set forth.

15232. "Improved method of and apparatus for recording and reproducing spoken words and other sounds." E. BERLINER. Dated November 8. 11d. Instead of moving the recording stylus at right angles to, and against the record surface, as in the ordinary phonograph, the inventor causes the same to move under the influence of sound waves parallel with and barely in contact with such surface; which latter is covered with a layer of any material that offers a minimum resistance to the action of a stylus operating to displace the same; all substantially in the manner of the well-known phonautograph by Leon Scott. The claims are 15 in number.

15319. "Improvements in telegraph posts or poles." A. MUIRHEAD. (Partly communicated from abroad by J. S. Blomfield, of Adelaide, South Australia.) Dated November 9. 6d. The inventor makes the said tubes of either circular or oval form in transverse section, and he inserts in the lower or larger end of the tube a strengthening or stiffening piece of peculiar construction. This strengthening or stiffening piece mainly consists of a plate or web which, when the said stiffening piece is properly inserted in the post or pole, extends vertically within the same and diametrically across the interior therefore in a plane parallel to the telegraph wire, that is to say, it occupies such a position that it will offer the maximum resistance to the bending stresses which the post or pole has to withstand. This vertical plate or web is provided with one or more plates or flanges at right angles thereto, which fit into the tube and prevent or diminish the liability to failure of the post or pole by collapse. The claims are 2 in number.

15329. "Improvements in machines or apparatus for covering insulated electrical conductors with lead or the like." R. W. EDDISON. (Communicated from abroad E. McKnight of Philadelphia.) Dated November 9. 8d. Relates to machines or presses of the type described in the specification of the patent No. 11,879, of 1885, granted to James Tatham, and this said invention has for its object to prevent injury to the insulating covering of the conductor whilst the insulating conductors are being covered with hot lead or other ductile metal. Claims:—1. In machines or presses of the type mentioned, the combination of the reservoir ram and die with a hollow core, forming a passage for an electrical conductor, and provided with a fixed lining of non-conducting material, with or without a thin metal tube or inner lining inside the said non-conducting material, all substantially as hereinbefore specified. 2. The combination of the reservoir ram and die of the press with the hollow core and its discharge nose, each provided with a non-conducting lining or packing, all substantially as specified. 3. The combination of the reservoir, ram and die of the press, the hollow core having an internal shoulder near the point, and a non-conducting core lining having a bearing upon said shoulder, all substantially as specified and illustrated in the drawings. 4. The combination of the reservoir, ram die and hollow core of the press, with a perforated pipe located adjacent to the die, and constructed to discharge streams of water or cooling medium upon the covering of the conductor as it issues from the die, all substantially as specified and illustrated in the drawings.

15730. "Improvements in galvanic batteries." J. VAUGHAN-SHERRIN. Dated November 16. 6d. Claims:—1. A galvanic battery in combination with a receiver connected by means of pipes with the battery cells. 2. The above provided with an axis and handle, and revolving in bearings or arranged in any manner that allows or facilitates the reversal of the positions of the cells and receiver from top to bottom, or from bottom to top, and so effecting an easy method of charging and discharging the cells from and into the receiver. 3. The charging and discharging of both single fluid and double fluid cells by means of the method.

16120. "An improvement in voltaic batteries." E. TYER. Dated November 23. 6d. Claim:—In combination with a battery cell or pot a channel and pipe arranged to operate in conjunction with a valve either for simple overflow or for complete discharge by siphon action according as the valve is open or closed, substantially as described.

CORRESPONDENCE.

Catalogues.

The style and tone of Mr. J. Slater Lewis's letter in your last issue, as managing director of the Telegraph Manufacting Company, show how keenly he has felt the truth of our letter, and well he may do, when on closer examination of their "Catalogue of cables, leads and insulated wires" for March, we find that there are 14 pages of prices and tables, 12 of which are copies of ours and others' lists, and only two may be regarded as original. We have also in your last issue the admirable and sarcastic letter of Mr. J. E. Kingsbury, pointing out the charming similarity of portions of the Telegraph Manufacturing Company's much vaunted catalogue of instruments to theirs.

If Mr. J. Slater Lewis does not consider it disreputable to copy other makers' price lists, tables and catalogues, and issue them as the production of his own company, clearly it is hopeless to do anything but leave your readers to pass their own judgment on such practices.

Walter T. Glover & Co.

April 10th, 1888.

[Bearing in mind the tone of Mr. Slater Lewis's communication of last week, we think that no good can come of further discussion on the question of catalogues.—EDS. ELEC. REV.]

An Electro-Motor for Tramcars.

There has been a great deal of talk about patent motors of various kinds for the driving of tramcars, although up to now almost next to nothing has been done in England. I therefore venture to give you my idea and views for a suitable electro-motor for the above purpose, and I hope you will find a spare corner in your valuable journal.

It will be self-evident that it may be driven by taking the current from the rails as well as with an accumulator. If accumulators are used, I would propose to carry them in a separate truck, and not in the car itself; this truck could run behind the car or in front, with its set of storage cells, and thus supply the electro-motor, which should be fitted underneath the tramcar itself, and act as a tender does to a locomotive.

The cells could be stored in sets above each other, for compactness, thus making the truck not more than half the length of the car. One set of cells could then be left to be charged while another was operating the car.

Fig. 1 represents this, and will explain itself.

My idea for an electro-motor is to place two armatures on one axle or shaft, and instead of employing two sets of field-magnets to employ only one, and so arrange this one field-magnet that it will be movable and can be used to operate either armature by being made to slide from one armature to the other; this could easily be accomplished by using rack gear, toothed wheels, or in many other ways; for instance, by means of a sliding screw.

The plan is very simple, and will lend itself in a variety of ways.

Double brushes will allow either armature to run in

either direction, the power being transmitted from the ends or any suitable part of the motor shaft; a sliding

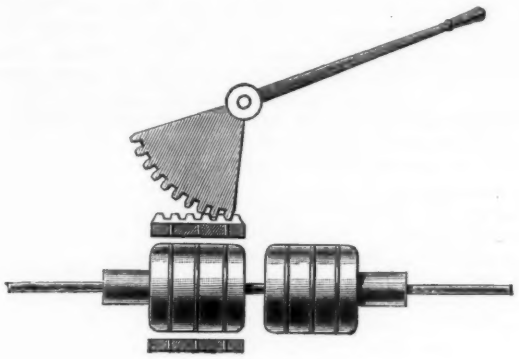


Fig. 2.

magnet may be of some service in certain electro-motors.

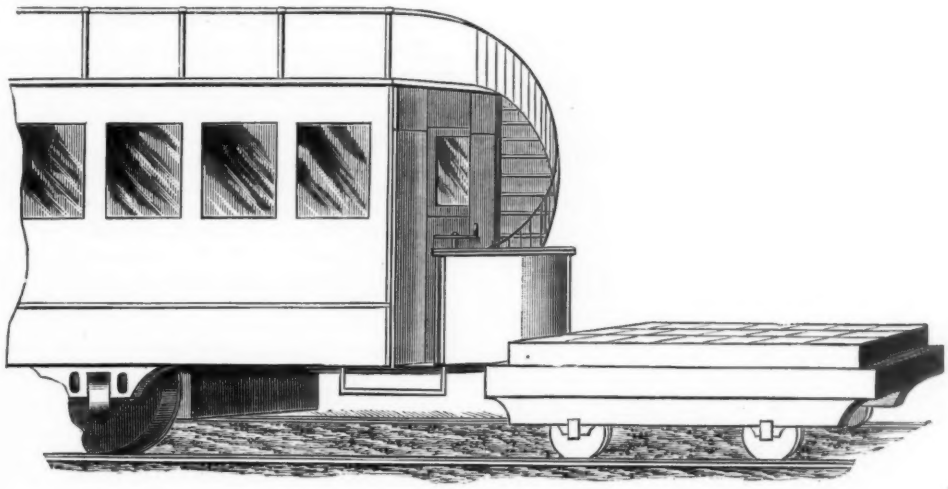


Fig. 1.

Fig. 2 will also explain itself.

The above idea may be of use to many engaged upon tram work. If so, it will satisfy me to know that I have helped on a subject that deserves more attention than it has yet received.

C. E.

[We are afraid our correspondent has not suggested anything which can be called an advance in electric traction. Mr. Jarman's motor will do all that "C. E." mentions without any sliding apparatus.—Eds. Elec. Rev.]

Insulating Electric Light Conductors.

To everyone interested in practical electric lighting the question of the insulation of conductors is of supreme importance. Your numerous readers on this side of the Atlantic have followed the discussion on this subject in your paper with great interest, and have expected to learn much from your practical men.

I have been interested in the practical side of this question for the last four years in America, but confess to having learned a good deal from reading Mr. G. L. Addenbrooke's letter in your issue of March 16th. The old adage once more holds true, that one has to go away from home to learn news. The airy and self-satisfying manner in which this gentleman makes certain statements, and then endeavours to prove them by imaginary facts, is ingenious, but not new; and shows a lamentable ignorance of American customs.

The fact is that cotton covering soaked in paraffin or ozokerite is practically unknown as a covering for electric wires on this continent. The various boards of fire underwriters having several years ago forbidden the use of this class of wire owing to its inflammability, a fire-proof covering was then insisted upon, and this was considered more important than that the insulation should be waterproof. Some bright genius then put on the market a wire having a double-braided covering saturated with putty and white lead, and named it "Underwriters'." This covering was fire-proof, but when damp was about as much of an insulator as a wet sponge. Largely through the influence of the National Electric Association the evils caused by the use of this wire have been publicly discussed, and at length recognised; and "Underwriters'," or "Undertakers'," wire is now universally condemned, and the demand is for something better.

For pole or outside work the covering is usually several tapes or braids saturated in a tough bitumenous compound—the covering or insulation to be tough enough to withstand rough usage and abrasion, and to be non-absorbent and reasonably waterproof. For inside incandescent wiring where good work is to be done the specifications now almost invariably call for a rubber-covered wire, or for one or other of the well-known insulations of similar character, such as the kerite or bitite, a covering which, after 24 hours' immersion in salt water, will give an insulation resistance of so many meghoms per mile. This cannot be got by simply using a thin rubber tape, but the custom here is to have a solid wall of insulating material round the copper and protected by a braid, which, if necessary, can be rendered fire-proof by the use of our old friend the Underwriters' compound. Lead-covered wire has been tried and found wanting.

This is a very different kind of wire from that described by Mr. Addenbrooke, whose advocacy of a played-out and discarded insulation shows him to have been drawing upon his imagination for his facts.

W. M. C.

New York, *March 30th*, 1888.

Telephone Patents.

Mr. Swinton's letter in your last issue clearly refers to our advertisement, and being very misleading, calls for a reply.

The armature used by Mr. Swinton in his receivers consists of an iron strip fixed at each end to the two metal rings, between which the diaphragm is held. If the diaphragm be entirely removed, the armature will remain self-supporting. We understand it is on this

point that the United Company attacks Mr. Swinton's receivers.

It would be inferred from Mr. Swinton's letter that our receivers are similar to his own, but they are not. Mr. Moulton, Q.C., who has fought on the United Company's side in all, or most of its battles, has given his decided opinion that the Stanhope telephone does *not* infringe Bell's patent, and his opinion is supported by other eminent counsel.

We fail to see Mr. Swinton's motive in writing the letter referred to, which would more naturally have come from the plaintiff company had there been any ground for it.

John S. Sawrey, *Managing Director,*
THE STANHOPE COMPANY, LIMITED.

April 10th, 1888.

On perusing your excellent REVIEW last evening I came across Mr. A. A. Campbell-Swinton's letter. On the propriety of the use for advertising purposes of the recent injunction obtained, that Mr. Swinton points out, I will not stop here to discuss. But it is the last part of Mr. Swinton's letter that I feel I must severely, though most courteously, challenge, and which you, Mr. Editors, from your remarks, would seem to support. I shall look for a reply. This is the paragraph I refer to :—

"As a matter of fact, the United Company are attacking the receiver used by the Equitable Telephone Association quite as much as the transmitter ; and if their contentions can be upheld *all the membrane telephones now in the market are equally infringements.*" (The italics are mine.)

Now as the case is still "*sub judice*," it would be invidious to say all one would like to ; therefore I feel somewhat tied, but this *too general statement* that if the U. T. Co. win "all the membrane telephones now in the market are equally infringements" must not be let alone.

Now, everyone who constructs a membrane telephone bases its freedom from Bell's claim on the principle of the "English Mechanic telephone."

But what is an E. M. T. ? No sane person will say that because a membrane is used for a diaphragm therefore it is an E. M. T. Oh, no. *How is the armature attached to the membrane ?* And, indeed, this question is the whole earnest of the matter. In a letter of mine in your excellent journal of 24th June last year (and which might at the present juncture prove of interest to re-read), I stated that should the armature be *supported* by anything but the diaphragm, I thought that would constitute an infringement of Bell's claim.

This statement was brought about by an idea of making a good telephone by enclosing a single strip of thin metal between two membranes, closely adherent to one another. The whole was then to be clamped between the two usual rings. An arrangement of this kind would be nearly independent of moisture attacks. Or, as a friend suggested fully a year ago, to use an armature with radial strips enclosed between two membranes and clamped in the same way, as previously mentioned. But would this be an E. M. T. ? No more than the "man in the moon," and instead of anyone using devices of this kind, it would be just as well to use an entire ferrotype plate at once.

It cannot but be an erroneous statement that a membrane, say, of parchment, with an armature stuck in the centre, as in the original E. M. T., is an infringement of Bell's receiver. *And there are E. M. telephones in the market at present.*

But to support the above, let us go to Bell's disclaimer, and we read the following :—"And whereas I am desirous . . . . . of amending my said specification . . . . . and of confining the claims in the said specification to arrangements of telephonic apparatus wherein are employed *plate armatures, or armatures other than those carried by a membrane.*"

Well, Sirs, need we investigate farther ? Is not this extract about as plain as possible ? It is therefore surely clear that an armature *carried by a membrane* is as free as the sun, and is an E.M.T. On the other hand, an armature *not entirely carried by a membrane* is most doubtful, and is not an E. M. T. ; and, indeed, while the actions-at-law on carbon transmitters are legion, there has never been one on the E. M. T. during the eleven years and four months of Bell's patent. Nor can there, in the name of common sense, be ever such a thing. In conclusion, remember Mr. Editors, that in making the foregoing remarks I leave out entirely in the cold those oft-repeated contentions, *e.g.*, that it could yet be proved that the "Glasgow receiver" was really an anticipation of the Bell telephone ; or that the "Bourseul" telephone invalidates the Bell claim, &c. I simply base my remarks upon what I believe would stand to-day in any English court of law.

I repeat, then, that I cannot help believing that this statement of Mr. Swinton's, being far too general and inclusive, is therefore not correct, and is calculated to do the trade damage (is there any other which is already more damaged ?) as his letter appears to have been sent to several publications of note, apart from your own.

J. S. Ross.

April 7th, 1888.

Electrical Locomotion.

I notice with reference to the above, on page 355 of your current issue, an invitation to the Electrical Power Storage Company to guarantee a life of six months to a storage battery suitable for tramcar purposes.

This, it seems to me, should be a matter of little or no difficulty to the above company, as my experiences of the life of a considerable number of cells supplied by them for railway train lighting far exceeds this period, and this under circumstances which are generally considered most adverse to the well-being of accumulators, viz., being charged with current constantly varying between very wide limits, and sometimes exceeding the nominal charging current by over 100 per cent. They have been, moreover, many times half discharged and allowed to stand out of use for hours, and even days, and again brought into use without anything being done to them, and subjected to the same treatment as before. In addition to this, the oscillation and jolting which they have to withstand in a train seems sufficient guarantee that they would withstand the most severe strain which could possibly be put upon them in a tramcar, in which the conditions must be far more favourable.

F. W. Cooke.

G. N. Railway, Retford,
April 7th, 1888.

Incandescent Lamp Patents.

The new points of law respecting American patents opened in the Court of Appeal, London, by Mr. Arthur Shippey in the action Edison and Swan *v.* Shippey Bros., are causing a good deal of stir on this side of the Atlantic amongst American inventors, it being well known here amongst patent agents that to make an application valid in England for a patent it should be made by communication, in which case it then vests a legal interest in any patents *if signed in the United States.*

I hope the trade are supporting Mr. Shippey, who certainly deserves the thanks of the nation at large for the plucky manner in which he has opposed a monopoly of the incandescent trade. I am the last person in the world who would take one particle of honour from the man who is entitled to it, but undoubtedly to Sawyer-Man the credit is due of being the real inventors of the modern incandescent lamp, their patents being prior to Edison's, Swan's, or Lane-Fox's ; although to the latter the greatest credit should be accorded for the work done in connection with this matter.

John Bilton.

New York, *March 26th*, 1888.